Feasibility of Transporting Mainland Aggregate to Auckland

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Frontispiece

Terram Autem Filiis Hominum

"*The fruits of the earth for the children of men*."

Abstract

The Auckland aggregate industry is approaching a crisis situation: conflicting land use and amenity values in both urban and rural areas are relegating quarries to increasingly remote sites. This has lead to higher transport costs, increased wear and congestion on the roading network and the ability of the suppliers to control the market through decreased competition. A seemingly inexhaustible source of quality aggregate can be won from the West Coast of the South Island, where geomorphic action produces material and high rainfall and gravity transport it to the coast often threatening important infrastructure. This dissertation examines the plausible method and conditions to transport aggregate from the overstocked supply of Westland to the resource handicapped greater Auckland area.

Investigation involved literature review; meeting market authorities, contacting both local and central government authorities; and discussion with academics. It was found that the governance of the New Zealand Transport sector is currently in flux meaning only speculative projections can be drawn.

The West Coast river gravel resource is predominantly high grade aggregate greywacke and granite origin, with the proportion of low-grade aggregate schist increasing the further south the location. Sustainable extraction quantities from West Coast would need to be established prior to removal of large quantities of gravel. Access to the Port of Onehunga is restricted to 4 days a week and no barges are currently available due to the international demand for coal.

It is inevitable that the Auckland Aggregate resource will become exhausted. It was deduced that this will to occur between 2015 and 2021. The shipping of sealing chip to Auckland is currently feasible if a back load is negotiated. Shipping other aggregate types will become feasible as the native resource diminishes and the cost of compliance in Auckland increases further.

Table of Contents

Acknowledgements

I would like to offer a heartfelt thank you to all those who gave their time in listening to my questions, making suggestions and discussing the possibilities. Top of this list is Dr James Mackechnie, my supervisor, with an enviable ability to cut to the chase, to offer both wide and comprehensive advice along with timely encouragement – Thank you. David Stapleton from the Port of Greymouth was generous with his time and resources showing me about the Port of Greymouth and sharing his vision for the historic port; Kelvin Hardie and Pat Ganley of Ship Constructors were again generous with their time and advice, giving away much hard earned advice from years building and piloting barges and tugs. Thanks to Gary McCarrison, a long time Northland Civil Engineer, I found the Atlas Resources barging operation, invigorating my research no end. Thanks to David Bell, a UC Engineering Geologist who suggested I look at the West Coast rather than the entire South Island, thanks to Evan MacGregor , the Manukau Southhead Signalman who showed me around his operation and discussed the limitations of the bar along with a bit of history. I was enthusiastically schooled in the wonder of ‘Steelstone’ (melter slag) by Hendrik Wortman and Bill Bourke of SteelServ at Glenbrook Steel Mill, who also were able to offer a unique angle on the Auckland aggregate industry. Recognition must be given to my father, Stephen Brockett, for this project, like so many other endeavours of mine, is the result of an idea of his. A special thank you goes to Libby Peate for her assistance with a particularly tricky sine wave. Lastly, I would like to commend Ian Coombridge of Sea-tow for giving my enquiries the time of day and a potential customer focused type reply.

1.0 Introduction

1.1 Objective of the Project

The aim of the project is the reveal the issues behind what is required for the successful transport of aggregate from the South Island to Auckland.

1.2 Nature and Scope of the Investigation

The project was simplified by assuming:

- Westland is the most ideal aggregate source in the South Island
- Barging is the most ideal method for long distance inter-island transport
- The regulatory controls over such initiatives will not be as vexatious in the future

The detailed aims of the project were to:

- Qualify the Auckland aggregate industry situation
- Identify a technically suitable, plentiful, sustainable resource to supply the market
- Investigate the status of infrastructure to transport the material to market.
- Examine feasible options for distribution to clients
- Analyse similar undertakings from which to benchmark
- Identify incentives, current and future, that may help realise the scheme
- Identify restrictions that impede the scheme that would need to be addressed
- Examine previous and current attempts or plans to overcome these restrictions
- Ascertain the ideal circumstances under which this venture could occur and the path by which such a situation could be arrived at

1.3 Methodology

A thorough literature review was undertaken, analysing transport infrastructure, technical suitability of materials and history of the undertaking. The World Wide Web was used extensively to source current information and this was then checked using given contacts. Discussions were held with eminent academics, port masters, signal men, ship builders, leading New Zealand shipping authorities as well as local government. Documents on current Government reform affecting transport, commerce and infrastructure were analysed. A comprehensive list of questions was emailed to various establishments.

1.4 Philosophy and Limits to Study

From the outset of this study current realities have not been permitted to limit its scope. Unconfined questioning and deduction, it was reasoned, could reveal a plausible future hard to extrapolate from the trials of today: The rigors of compliance with resource management legislation, delicate Maori issues, various policies, plans, strategies, market uncertainties and corporate dynamics have been on the whole overlooked.

2.0 Auckland Situation

2.1 State of the Aggregate Industry

2.1.1 The Auckland Predicament

The demand for quality aggregate in Greater Auckland Area (New Zealand's largest aggregate market) is approaching a critical state. Auckland is pretty much out of rock, not because the resource is diminished but because poor planning has sterilised the resource. Conflict between quarrying operations and amenity values in both urban and rural areas is seriously affecting access to aggregate sources and lending to higher transport costs from increasingly remote sources. The search is now on for alternative sources to quell the exhaustion of quarried aggregate.

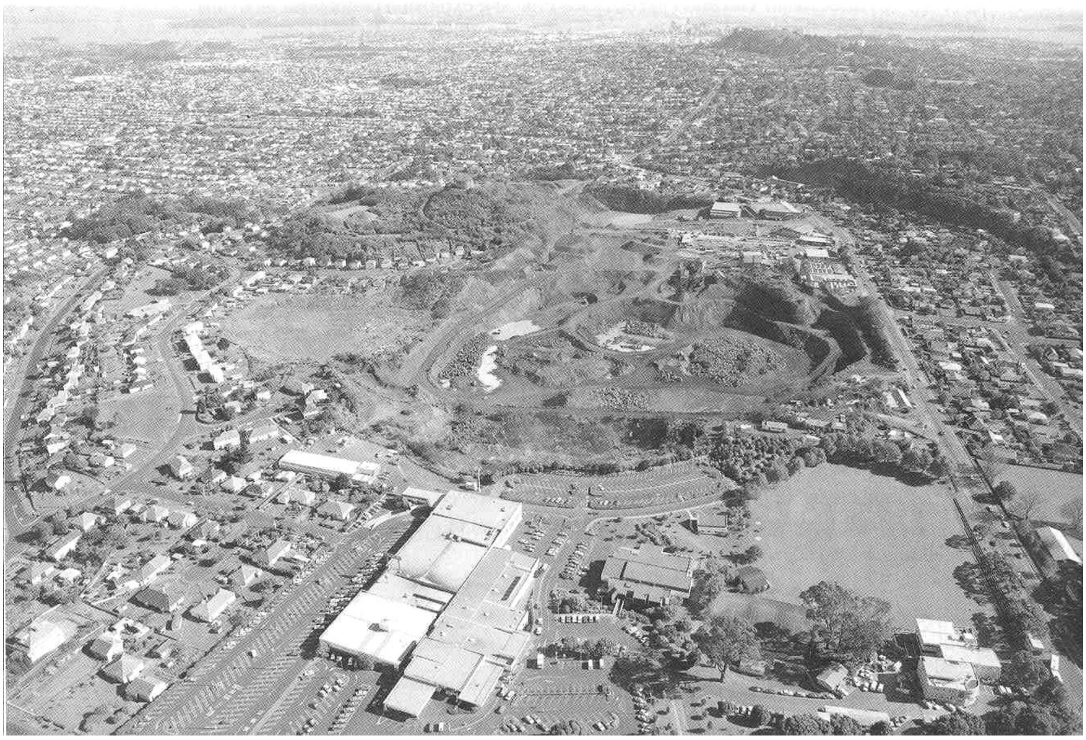

Figure 2.1: Three Kings Quarry, Surrounded my residential development

Auckland's aggregate industry has been growing in line with population and is experiencing further demand for high quality aggregates for use in its growing road network and the large corridor projects due to start in the region (Byers, 2003). The industry's increasing demand for raw materials is supplied by many operations and supply to the market is very competitive.

Quarry locations are constrained by planning and environmental conflicts. Auckland Regional Council (ARC) Regional Growth Forum survey showed support for increasing and diversifying open space to be protected by the council. This vision will be incorporated into district plans for years to come, resulting in no room to expand production from the few remaining basalt quarries and restricting quarries to peripheral areas.

Figure 2.2: Due to congestion the Auckland Harbour Bridge effectively divides the Auckland aggregate market in two.

Longer distance haulage has perpetuated an increase in demand for road transport raising concerns about the future ability of road systems to cope with the increasing traffic and associated noise problems. Currently, congestion on the Auckland Harbour Bridge (figure 2.2) effectively divides the market into two zones; with the northern zone having an inadequate supply of high quality aggregate. This shortage is off set by aggregate distribution centres sited within the zone supplied by South Auckland quarries or deliveries at night (section 2.1.5).

Longer haulage results in higher delivery costs and in turn higher on site aggregate prices. In the mid 1990's 0.4 MTPA were being transported over the Bombay Hills to Auckland. Assuming fully loaded truck and trailer units can carry 30 tonnes of aggregate this is 58 truck and trailers per day. It is estimated that by 2010, this will have increased to 358 truck and trailer per day (assuming alternative transport options are also utilised) (Whitehorn, 1999), (to transport 4 MTPA). Winstone Aggregates suggests transport costs could rise from an average 30% of delivered cost to about 45% and 55%.

Establishment of new quarries is becoming increasingly difficult. The Auckland sites are predominantly urban or under threat from the reverse sensitivity effects of encroachment on rural residential development. Potential sites within peripheral areas have been subdivided into many high value lots for lifestyle blocks requiring a quarry developer to deal with many landowners. Increased controls on development, increasing requirements for consultation; including landowners, Maori, regional government and other regulatory authorities result in unmitigated lengthy times from exploration to permitting.

Increased compliance costs are a further encumbrance to the industry: environmental controls concerning dust, noise, water draw down and silt runoff; quality controls such as Transit NZ's new sealing chip standards requiring a higher number of broken faces (resulting in increased crushing, increased fines, marginalizing some operations) all add to the unit price. The conclusion of existing transition regulations governing the high use of heavy vehicles on low level roads and the resulting reduction of existing roads life expectancy will possibly see additional road user charges. Increased demand on the road network also increases demand for quality aggregate as additional maintenance and construction work ensues.

2.1.2 Sources

Many of Auckland' basalt flows and scoria cones that erupted in the last 60,000 years between the Auckland International Airport and Takapuna have been quarried. Rock is extracted from a number of sites around Auckland for use as aggregate in building and roading, as construction fill and as track ballast. Basalt lava is the only local source of good quality building aggregate. Lunn Ave, Mt Wellington Quarry (closed in 2001) had been producing 50% of Auckland's aggregate requirements. For several decades the railway quarry at Wiri produced very durable track ballast for much of the northern half of the North Island

The pre 1964 history of aggregate production is not well documented, but some quarries have operated since the middle of the 1800's. The aggregate industry has used more than 160Mt of quarried rock since 1964 (GNS, 1992). Rock types used with the Auckland region are listed in order of decreasing output below:

1. Basalt lava, scoria and associated tuff – dense material is crushed for chip, concrete, ballast and basecourse uses. Scoria is used for light weight aggregate and drainage systems. Tuff is mainly used as fill. Basalt from 160 quarries has amounted to 90Mt (55% of the regions production). – *Lunn Ave*, *East Tamaki*, *Wiri* produce/d basalt; *Three Kings, Puketutu Island* and *Wiri South* produce Scoria. *Ridge Road*, *Bombay*, *Pukekawa* and *Pokeno* quarries in the Franklin area produce deeply weathered basalt.

2. Sedimentary rocks – un-weathered greywacke is crushed and used as basecourse, concrete and chip. Production is 41Mt to date (26%) – *Warkworth, Whitford, Hunua, Whangaripo, Omaha, Brookby,* and *Drury* quarries produce this material.

3. Basalt and andesite lava – an important local Waitakere source. Mainly used a roading aggregate as conglomerates are not suitable for concrete and chip requirements. 4.5Mt to date. – *Waitakere and Hukatere quarries*

4. Tangihua Complex – *Mt Braeme* and *Flat Top* quarries; due to weathered nature mainly used as base-course.

5. Albany Conglomerate – mainly igneous pebbles in a sandy matrix. When crushed produces high quality aggregate. Readily accessible, but under-utilised, 2 Mt to date. – *Wainui* and *Coatesville* quarries supply this.

6. Gravel – isolated pockets of shingle comprising mainly of greywacke pebbles occur just offshore from many Auckland low lying coastal areas. Usually have size grading suitable for concrete aggregate. Quarries include: *Kaiaua*, *Managatangi*)

2.1.3 Restrictions

West Auckland - urban encroachment has seen potential resource areas being contained in areas protected from development because of their recreational, scenic, ecological and water supply values.

Puketutu Island – only previously disturbed areas are quarried to avoid damage to scientific, landscape, archaeological and Maori values.

Three Kings – dewatering programme strenuously opposed by a hard core of local residents. ACC's District Plan zones the Winstone Aggregates Three Kings Quarry "Business 7" and subject to a number of rules regarding land use, for example, noise and vibration from operations, quarrying is a permitted activity on the site. Over the last 10 years Winstone has also either renewed or obtained through resource consent applications permits from ARC that allow it to operate legally. In particular an air discharge permit and a permit to take groundwater to dewater the quarry to allow quarrying on land presently owned.

Hunua and Drury – the Auckland markets two largest producers. Expansion is limited by trucks transports routes and encroachment on rural residential development.

Pokeno –Winstone Aggregates have proposed a quarry in the South Auckland Basalts at Pokeno to help offset the closure of their Lunn Ave Mt Wellington Quarry. It is located adjacent to State Highway 1, the North Island Main Trunk railway and within 50km of the centre of Auckland. Located within an ancient crater within a hill i.e. noise, air blast and dust and visual effects of extraction are lessened. The Quarry's story is case in point of how objectors can unduly and unreasonably hold up consent applications. An incorporated society became a 274 party to the Pokeno Appeals. That is, they only joined in at the appeal stage. In the Environment Court hearing, 10 witnesses gave evidence on behalf of the society, none of whom were an expert on environmental effects, supposedly their concern. The Environment Court granted full consent to the Quarry. The society then appealed this decision to the High Court but the appeal was struck out on the grounds that the appeal was a frivolous attempt to abuse the processes of the Court. The society then issued judicial review proceedings which have subsequently been withdrawn, leaving Winstone to exercise its consents after six years and $2.5 million spent in gaining them. The Pokeno community voted to endorse the draft Heads of Agreement between the Pokeno Protection Association, Winstone Aggregates Ltd and Franklin District Council. The agreement includes provisions governing noise, dust and vibrations, and enforces a restriction on yearly aggregate tonnage (1.5 MT) which cannot be increased throughout the life of the Pokeno quarry. The agreement is legally binding to whoever owns and operates the quarry. The company plans to transport most of the product to central Auckland by rail.

Reliable Way – hours restricted to 9am to 4.30pm, strenuous blasting restrictions, dust monitoring 24 hours a day, monthly meeting with locals, yearly audits to ensure compliance.

2.1.4 Production

From 1967 to 1993, Crown Minerals and its predecessors published annual quarry production statistics, including statistics for most individual operations. Due to the Privacy Act and other commercial sensitivities from 1994 until present the individual quarry statistics are confidential and only regional summaries are publicly available. It is now difficult to establish the status of many operations. Table 2.1 is the best known quantification of Auckland's remaining aggregate stock.

Table 2.1: Auckland Aggregate Supply Outlook (Byers, 2003)

Quarry	Estimated Resource (years)
Drury	25+
Hunua	25+
Bombay	15-20
Atlas	15-20
Clevedon	15-20
Flat-top	15
Waitakere	15
Three Kings	10
Ihumato	10
Ridge Rd	8

2.1.5 Industry Players

2.1.5.1 Winstone Aggregates

Winstone is the largest supplier of aggregates in Auckland and in New Zealand and is part of the Fletcher Challenge Group. It owns and operates its own fleet of 24 bulk truck and trailer units carting, as well as aggregates, fertiliser, grain, gypsum, coal and other products to anywhere in New Zealand. Nine of its sites are in the Auckland area and these supply 40% (2001) of the crushed and screened aggregate used in the area.

<u>Albany Distribution Centre (13 kms N of CPO)</u>
Henry Rose Place, Albany

Products: Roading, Drainage, Sand, Bulkfill

<u>Flat Top Quarry (32 kms NE of CPO)</u>
Haruru Rd, Kaukapakapa

Products: Roading, Drainage, Bulkfill, Landscaping, Erosion Control, Farm Maintenance

<u>Lunn Ave, Mt Wellington</u>
Lunn Ave Quarry opened in 1936 and for many years supplied over 50% of Auckland aggregate needs until it closed in 2001.

Figure 2.3: Lunn Ave, Mt Wellington, now closed

Hunua Quarry
Hunua Gorge Road, Papakura

Products: Roading, Concrete Aggregates, Bulk fill Drainage, Asphalt, Farm Maintenance

Figure 2.4: Hunua Quarry and semi-rural surroundings

Pukekawa Quarry
Smeeds Quarry Rd, Pukekawa

Roading, Drainage, Erosion Control

Puketutu
Puketutu Island Quarry, Island Rd, Mangere

Roading, Clean fill, Landscaping, Drainage, Bulk fill, Sand

Three Kings
Mt Eden Rd, Three Kings
Scoria, Roading, Backfill

Helensville
Kaipara Harbour sand dredge landing, open 7am – 5pm

2.1.5.2 W. Stevenson & Sons Ltd

Stevenson's is a family owned company. They currently move over 1.0 MTPA. Their fleet of 11 bulk tipper trucks move metal, scoria, sand, fertiliser, lime and maize. Stevenson pioneered a night-time bulk delivery service to counter the ever-worsening traffic congestion in Auckland. The quiet trucks operate with a strict no engine brake rule and have foam rubber fitted to the tailgate edges to meet noise level regulations.

Drury Quarry
Drury quarry was established in 1939, is one of the largest in Auckland and has the advantage of being close to the Southern Motorway. The quarry produces greywacke rock, for base course, concrete aggregate, paving and construction. Sealed access and four loaders dedicated to load trucks enable the weighbridge to handle over 500 trucks per day.

Kaiaua Quarry
At the Kaiaua quarry on the Firth of Thames, alluvial gravel is won by dragline from gravel deposits. The shingle is mainly crushed into concrete aggregate or used for decorative garden and architectural products such as shell, pebbles and boulders for the Auckland market. The "*B K Subritzky*", (figure 2.5) is a specially designed vessel used to ship bulk metal from Kaiaua Quarry to the Silverdale Batching Plant up the Wade River on the northern outskirts of Auckland.

Figure 2.5: B K Subritzky

Huntly Quarry

The Huntly quarry on the Waikato River produces greywacke for roading and concrete aggregates for the Waikato and Auckland regions.

2.5.1.3 Holcim (NZ) Ltd

Holcim NZ Ltd (formerly *Milburn*) is Swiss owned and a global producer of cement, ready mixed concrete and aggregates. It is the second largest producer of aggregates in New Zealand; they operate *Readymix* concrete in partnership with *Allied Concrete* and produce and distributed half of New Zealand's cement resource mined at Cape Foulwind (see section 11.5.1). Holcim are a major user of the Port of Onehunga for the purposes of cement distribution and storage.

Bombay Quarry,

Ridge Road Pokeno, has a 13 million tonne deposit of high grade basalt 70 metres thick. Its primary production is about 400 tonnes per hour and its aggregate production around 250 tonnes per hour.

Manukau Quarry

Wiri Station Rd, Wiri (Figure 10.3).

North Shore Distribution Centre

Paul Matthews Dve, North Harbour

2.5.1.4 Fulton Hogan

Reliable Way

Reliable Way, Mt Wellington

2.5.1.5 I H Wedding & Sons Ltd

Wedding supplies aggregates from Huntly and offers a competitive restraint in the South Auckland region. They are able to cart from Huntly to Auckland for $9/t (Ganley, 2004)

2.5.1.6 Concrete Recycling

There are currently about a dozen companies that crush concrete for use as roading and concrete aggregate, the largest being *Ward Demolition* and *Adam's Landscaping Ltd*

2.1.6 Future Sources

The rock to the North of Auckland is in isolated forms and is also little respected for its quality. The closest rock aggregate resource of substantial size is in South Auckland and Waikato. Transporting this aggregate to the Auckland market will significantly impact the region's motorway network. Some South Auckland (Pokeno) and Waikato sites could utilise rail. Both Waikato and Coromandel sources could use barge. With the mounting cost of

Auckland aggregate there is increasing economic potential for importing aggregate from as far as the South Island.

To mitigate a shortfall in the market: careful regional land planning by District and Regional Councils needs to implemented safeguarding utilisation of potential quarry sites; substandard resources should be enhanced with additives, such as lime or cement stabilisation; use of recycled materials could be increased within the construction industry and aggregate supplies imported. The dynamics of the industry inflict a reluctance to change: current infrastructure and supply chains are expensive and time consuming to re-jig. Such changes will not come easily.

2.2 Other Auckland Issues

2.2.1 Population Growth

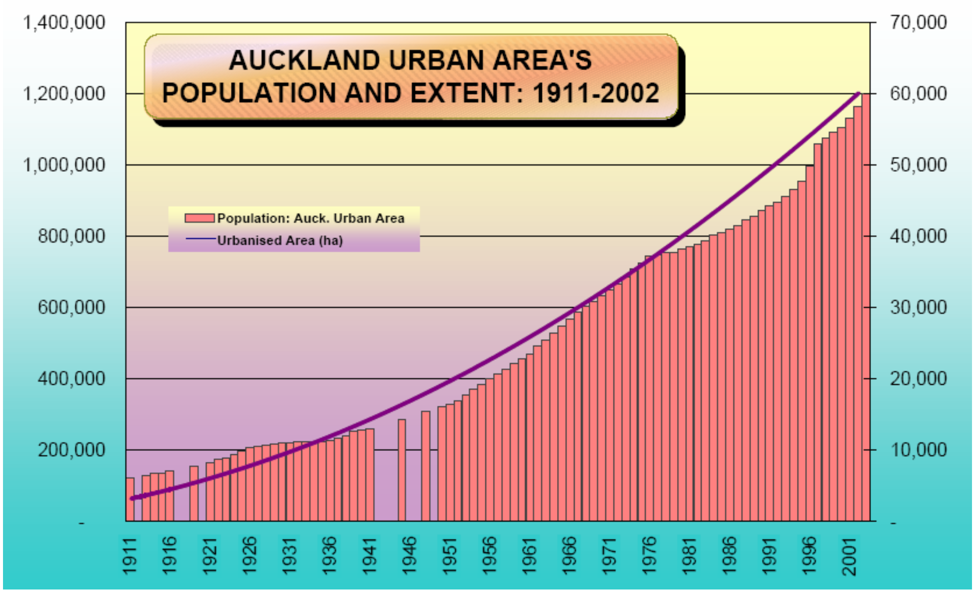

Figure 2.6: Auckland's Annual Population Figures since 1911

The Auckland region's population is growing fast (figure 2.6). Every day it increases by 49 people. Every week around 150 new houses or apartments are needed to accommodate them. Every day 35 more cars drive on the region's roads and another 18,000 people enter the region every year. Over 32 % of New Zealanders now live in Auckland. In order to deal with the growth and increased pressure on the infrastructure and environment, the Auckland Regional Council (ARC) has developed a Regional Growth Strategy. Without a positive strategy to deal with this growth Auckland will become increasingly congested and polluted. This is complemented by a number of other ARC documents: The Regional Land Transport Strategy, the Regional Passenger Transport Plan, and Auckland Regional Economic Development Strategy (ARC, 2003). The fastest growing regions within Auckland, as At June

2003, are detailed in table 2.1 (Note that Rodney is an area with poor local aggregate sources) while 56% of New Zealand's total growth occurred in the Auckland region.

Table 2.1: Growth rate of Auckland's fastest growing regions

Region	**Growth Rate**
Rodney	3.7%
Auckland City	3.4%
Manukau City	3.3%.

The size of Auckland's population and it's geographical, commercial and political dynamics have led to a number of compromises and often crisis. Two case studies are given below regarding the need to plan for growth.

2.2.2 Water Supply

Water from Waikato - Following the 1994 Auckland water shortage a supply pipeline to the Waikato River was constructed. It draws water just prior to the rivers discharge point into the sea; from there it is treated and 50,000 m^3 a day is then piped 38 kms to Auckland to supply up to 15% of the regions water needs. It is expected that by 2030 it will supply 150,000 m^3 of water a day. The pipeline and treatment plant cost $155 million (Watercare, 2004).

2.2.3 Power Reticulation

After a series of 4 power cable failures on 20 February 1998, the major distributor and retailer of electrical power to the city of Auckland, announced that it could no longer supply power to the central business district. Emergency services were notified and mobilised. The debacle lasted until the 27th March (5 weeks). It affected 60,000 workers alone, businesses had to relocate out of the CBD or fly in generators from overseas; with 58 installed by the power company themselves. The fault was found to lie, on the whole, with the power company, namely their risk management and contingency planning, and its operations and asset management practices. Corporate governance was also identified as an issue. The resulting investigation recommended industry wide improvements in security of supply for reasons of both infrastructure security generally and for New Zealand's international reputation.

2.3 Local Authorities

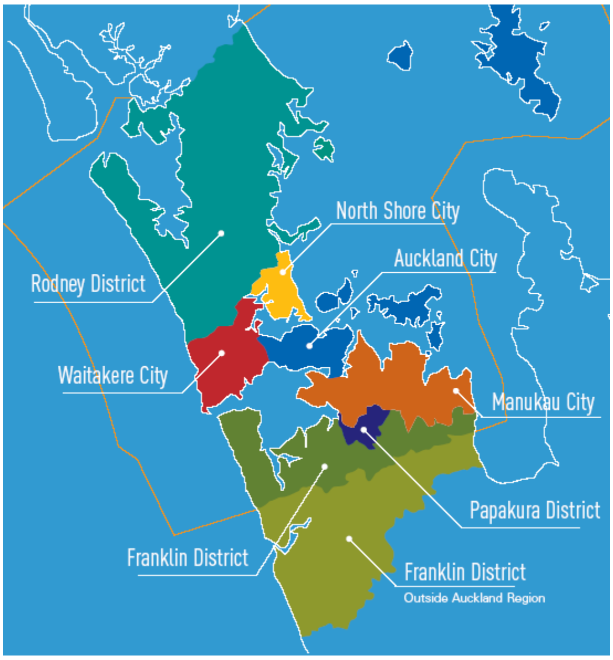

Figure 2.7: Auckland Territorial Authorities and Boundaries

The greater Auckland region has eight territorial authorities: there is the *Auckland Regional Council* (ARC) who cover all the shaded regions in figure 2.7 except for the southern half of Franklin which is outside the region; then there are the 7 district councils, with their respective areas indicated in figure 2.7: *Rodney District Council*, *Waitakarere City Council*, *North Shore City Council*, *Auckland City Council*, *Manukau City Council*, *Papakura District Council* and the *Franklin District Council*.

2.4 Infrastructure

2.4.1 Ports

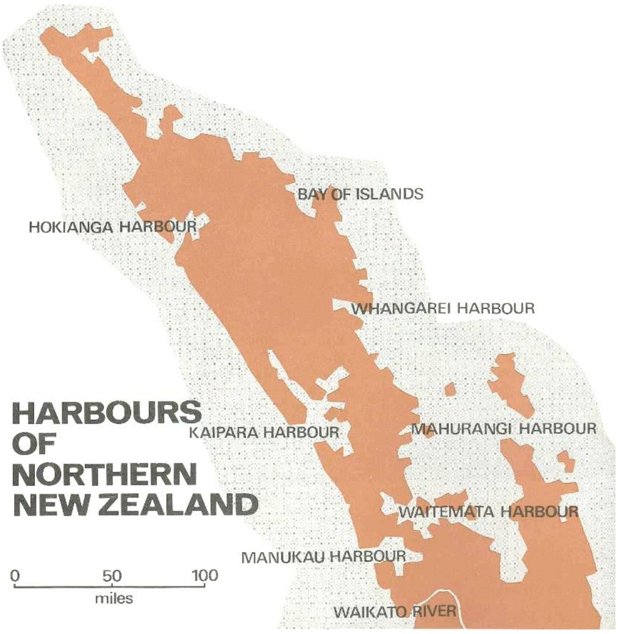

Figure 2.8: Harbours of Northern New Zealand

2.4.1.1 Manukau Harbour

Bar Considerations

Despite its large area the Manukau Harbour has an entrance only 1500m wide, which coupled with the prevailing coastal currents has formed a shifting sand bar, curving several miles offshore across the harbour entrance. The bar is about 10 miles long and its actual position changes as does the channel through it. At low tide the depth is about 5.5m, but turbulent conditions prevail in the area and mariners must exercise great care in crossing. To maintain a watch on the bar POAL employs a signalman, Evan MacGregor, who lives in a house afforded panoramic views of the area 180m above sea level on the South Head. He reports bar and weather conditions to the Port and to shipping. By using UHF radio channel 11, the signalman is able to assist shipping through the channel and over the bar. Due to the bar, the harbour has a 6.1m maximum working draft (5.9 – 6.0m in reality) and is a daylight only / full moon port (MacGregor, 2004).

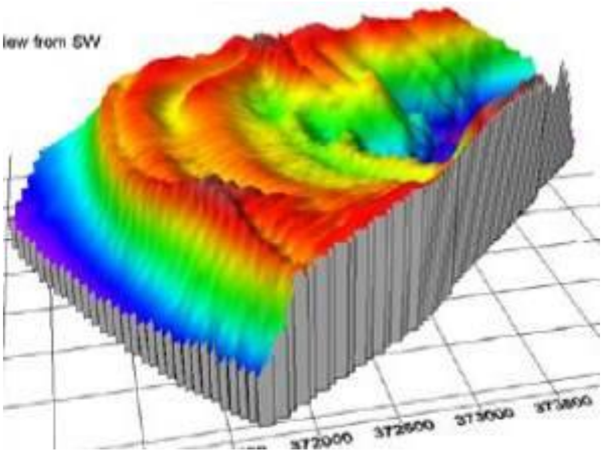

Figure 2.9: 3D image of bar entrance to Manukau Harbour

The POAL Marine Services section operates a dedicated Hydrographic Survey Division. The division maintains a periodic seabed mapping survey of the harbour entrance (figure 2.9) and environs.

Figure 2.10: Auckland Airport and Manukau Harbour

Port of Onehunga

The Port of Onehunga services coastal traders, handling containers, roll-on, roll-off cargo, cement, aggregate, dolomite, and fish. It has a berth length of 282 metres, including a roll-on, roll-off ramp; an operating area of 5.2 hectares, a hoist and berths for fishing boats. Major customers are Pacifica Shipping and Holcim Cement (POAL, 2004).

The port is 27 kms from the entrance. The controlling depth in the channel is 3.3 m. Tidal range is 3.4 m springs and 2.0 m at neaps. It is within 3 km of the large Penrose-Westfield-Otahuhu industrial area. Depths alongside the wharf range from 3.5m to 4.5 m at Chart Datum. Transit sheds provide a total of 3,500 m^2 covered storage area. The wharf has both road and rail access, but rail is not currently used. (At risk from Holcim plans to in-fill the tracks) (Scott, 2004).

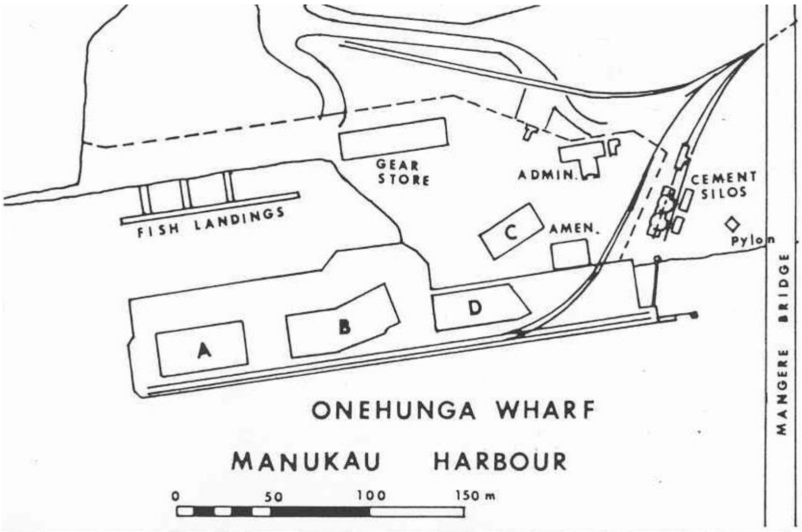

Figure 2.11: Plan of Onehunga Wharf

The wharf is equipped with transit sheds, a cargo gear store used by shipping firms, office and administration buildings and a cement silo at the eastern end of the wharf. Ships using the port have use of a tug *Tika* and a pilot. The 47.7 tonne, three-crew, twin screw powered tugboat has 8 tonnes bollard pull. The POAL Hydrographic Survey Division periodically does soundings and a hydrological survey. The wharves and channel are dredged every 18 months. Future port developments for the Port include moving of cargo shed, rail tracks are to be filled in and Holcim are to commission new storage.

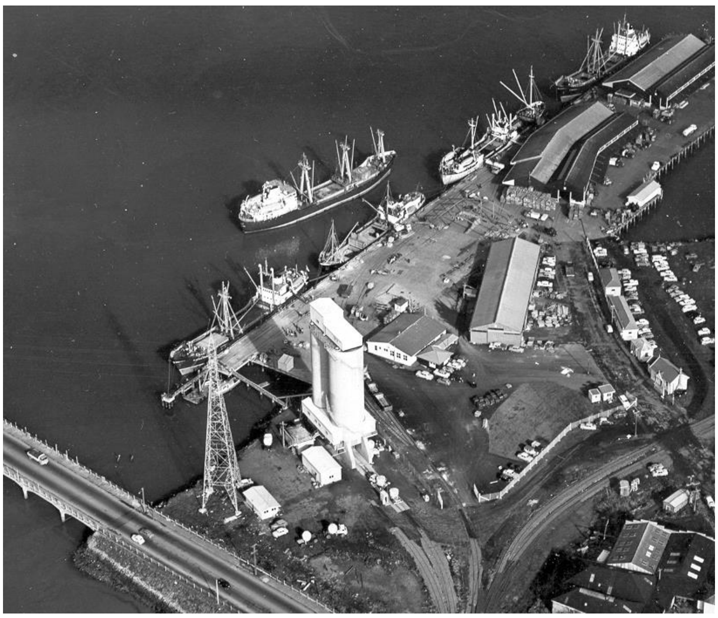

Figure 2.12: Port of Onehunga in its prime

The Port is owned by Ports of Auckland Limited (POAL) who are in turn a public listed company 80% owned by the Auckland Regional Council (Through Infrastructure Auckland (AI) – soon to be Auckland Regional Holdings (ARH)). See section 9.1.5.1. The Onehunga operation falls under the “Marine Services” section of the “General Wharves” branch of POAL. The director of Marine Services and Port Manager is Wayne Mills and his assistant is Roy Scott (see Appendix A4.7 for contact details).

There are a number of considerations due to the ports tidal nature. It takes 2 hours to get from port to the harbour entrance, this has to be co-ordained with other vessels as if they cross they need somewhere to pass, communication needs to be maintained with South Head (Signal-master), there is no coming over the bar at night and if the port is occupied there are limited anchorage areas (Lowry Pt or Big Bay). For the port there is a workable draft of 5m (5.9 maximum seen). A recent aggregate shipment from Greymouth was forced to head around North Cape to the Waitemata Harbour on the east side of Auckland because of bar (Scott, 2004).

Figure 2.13: “A Wharf” (Left), Roll-On-Roll-Off Ramp (Top Right), “B Wharf” and cement silos (Bottom Right)

Vessels wishing to use the wharf casually are subject to a number of constraints: “B-Wharf” is a dedicated to Holcim’s facility and is not available; Pacifica have exclusive use to the other “A-Wharf” from Thursday through to Saturday. The window for use may be further restricted if Solid Energy's plans to supply coal to Huntly is shipped through the port. Due to little on site storage area, the Sea-Tow / Solid Energy coal barges that currently use the port are required to remove cargo off site as it is unloaded.

Liquigas Pontoon

This is a floating pontoon LPG terminal operated by Cape Shipping in the Papakura Channel opposite the airport on the Manukau Harbour. At the terminal coastal tankers unload LPG where it is conveyed by underground pipeline to an onshore depot. The size of the tankers used is indicated by the former *MV Tarihiko* in figure 2.14; a 1000T tanker specially built to land LPG in the Papakura Channel.

Figure 2.14: Coastal tanker (formerly the MV *Tarihiko*).

Wiri Terminal

On account of the terminal's shallow draft it is "near exclusion" (Bradshaw, 2004) and it is difficult to navigate there. It is operated separately to Ports of Auckland (none of POAL pilots or tugs do work there). Further information can be sought from the ARC or John Lee Richards, the Waitemata and Manukau Harbour Master, c/-Auckland Regional Council.

Waiuku

Despite plans in the mid 1960s to establish a port behind the Glenbrook Steel Mill the former "Port of Franklin" (See Appendix A1.3.3) the port today is abandoned with the ninety-year-old scow Jane Gifford moored up at the jetty at the Tamakae Reserve, across the road from the Kentish Hotel.

2.4.1.2 Kaipara Harbour

<u>Bar Considerations</u>

The Kaipara Harbour draws in sand from the West Coast long shore drift. The harbour is not a 'manned' harbour and there is no harbour control. It is a dangerous bar harbour and is not used for commercial cargo.

<u>Poutu Barge Landing Facility</u>

Extends 20m out, Built by Rex Shipping in 2002 for "Mr Woodcock" (Reeves, 2004).

<u>Quarry Point</u>

Please refer to section 11.1.1.

<u>Port Albert</u>

Port Albert is the site of a failed early colony settlement. What depth of water was there has now gone and only the jetty in figure 2.15 remains as a testament to settlers landing site (Ganley, 2004).

Figure 2.15: Wharf at Port Albert, Kaipara Harbour, 2004

<u>Helensville</u>

Both Atlas Resources and Winstone Aggregates mine Kaipara Harbour sand with suction dredges and operate separate landing wharves at Helensville.

2.4.1.3 Waitemata Harbour

Figure 2.16: Auckland City and the Waitemata Harbour

The Tamaki River can handle small barges (up to 1500T) (Coombridge, 2004) and has limited room for barges (Ganley, 2004)

<u>Panmure Wharf</u>

Located on the Tamaki River, this wharf is used as an aggregate port and is close to the Mt Wellington industrial area.

<u>Gabador Place</u>

This wharf is on the Tamaki River and is used by Stevenson's mainly for sand from Pakiri. (Bradshaw, 2004)

<u>Ports of Auckland</u>

Ports of Auckland Ltd is a publicly listed company with 80% indirectly owned by the Auckland Regional Council and 20% of its shares publicly owned. Wynyard Wharf is used for aggregate, mainly sand, which by necessity is immediately trucked out. The busy and relatively expensive downtown wharfs of the Ports of Auckland have logistical shortfalls such as lack of storage, but have recently improved road and rail links (Bradshaw, 2004).

<u>Devonport</u>

Devonport is currently home to the Royal New Zealand Navy, it has excellent berthage with 7m draft and 35 acres of Navy land alongside. If the site became available for commercial use it would be restricted by motorway access being via congested residential streets.

Chelsea Sugar Refinery

Currently the Chelsea facility only services the sugar works; although extensive nearby areas are zoned but not used for industrial purposes (AHB, 1975). The wharf face is 91 m long and a typical vessel to visit is:

LOA: 170m. Beam: 26m. DWT: 28,000T. Max Draft: 9.8m.

A shore based crane is used to discharge Sugar, but this is not suitable for any other cargo discharge. A vessel arrives every 6 weeks and takes less than a week to discharge. If aggregate barges were to use the wharf they would need to be discharged directly into trucks and there would need to be consideration given to traffic volumes and hours of operation as all transport leaving Chelsea pass through a residential area (Grant, 2004).

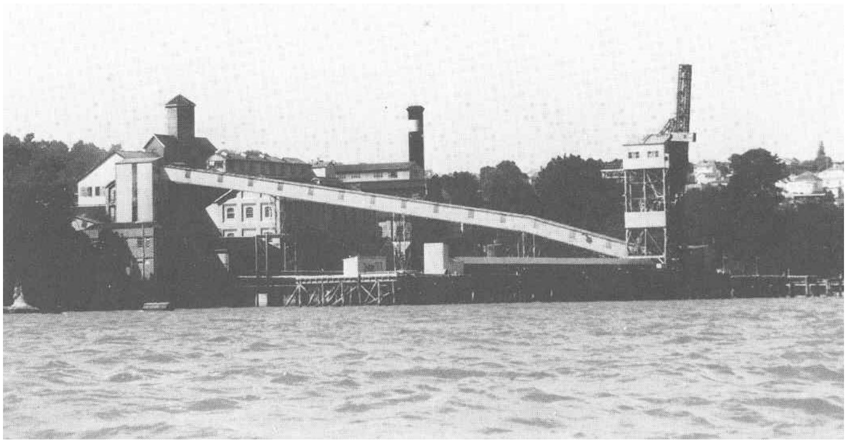

Figure 2.17: Chelsea wharves

Kauri Point

Royal New Zealand Navy Armament Depot is afforded excellent deep water berthing facilities and surrounding land. With the continued downsizing of the armed forces this site may become available for commercial use. It currently is not open to the public and is also hampered by the surrounding residential development with no clear arterial road to a motorway.

Lucas Creek

At the end of Rame Road an area was reclaimed and was used for boat building (may still be). Draft unknown

Hobsonville

Retired Defence Force land, used once by flying boats is now a marine hub for building yachts. The site is adjacent to deep water with much undeveloped land available alongside. Whenuapai Airport re-development is across the road.

Henderson Creek
Selwood Road landing used to transport sand and shingle.

2.4.2 Railways

Auckland currently has an extensive rail system with 92km of tracks. The Eastern and Southern Lines form part of the North Island Main Trunk Line, which carries freight to and from the Ports of Auckland. A recent audit of the network by the LTSA concluded that the Auckland rail network is 'fit for purpose' but substantial renewal works are necessary to retain network integrity and ensure public safety. Physical track and signalling constraints on the present network limit peak service provision to the current timetable. The quality of existing corridors, rolling stock and service is a further inhibitor to attracting new customers to rail, although the opening of the Britomart transport inter-change has led to material increases in rail passenger traffic.

Figure 2.18: Onehunga – Penrose Branch Railway in disused state.

The track was laid primarily for freight rail purposes and under the new transport regime (section 7.1.2.2) is being upgraded to accommodate the more intense usage and higher capacity requirements of a passenger transport system. The Crown recently purchased back an 80 year exclusive right of access to the rail corridors from Tranz Rail as well as all infrastructure within the corridors, including signalling and train control systems and equipment. This is now controlled by the State entity New Zealand Railways (NZRC). A private company called Connex runs the passenger trains.

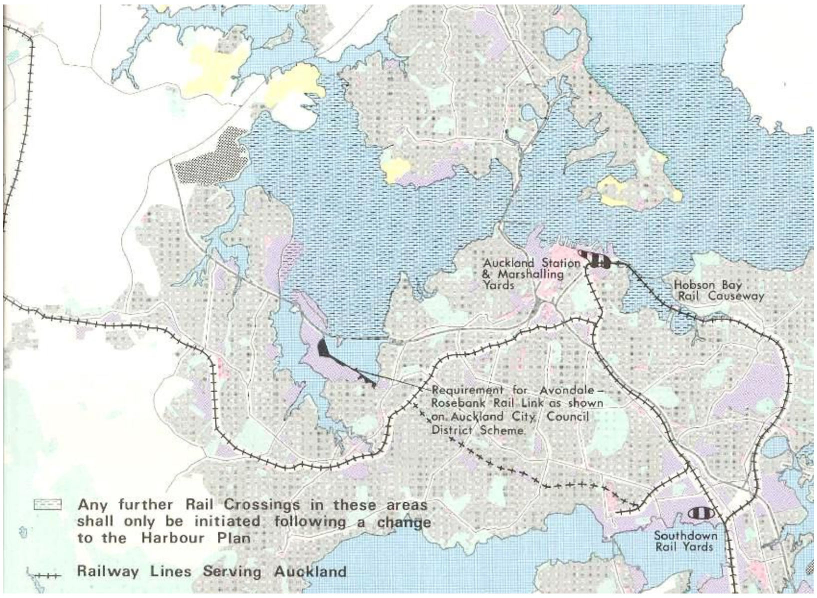

Figure 2.19: Map of Auckland’s Rail System

2.4.3 Roading

Figure 2.20: Auckland’s State Highway Network

The regions motorway network is currently receiving major extending and debottlenecking. The South Western (SH 20) Motorway is being progressively extended south to join the Southern Motorway (SH 1) and north to join the Western Motorway (SH 16). There are controversial plans for a motorway standard route through the eastern suburbs with major grade separated intersection works currently underway to connect this route to SH1. Across the northern boundary of the Waitemata Harbour the Upper Harbour Highway (SH 18) is being upgraded to motorway standard along its length including the duplication of the Upper Harbour Bridge. The Northern Motorway (SH 1) is being extended north 7.5 km between Orewa and Puhoi.

3.0 Demand

3.1 Market Analysis

3.1.1 Market Area

This project focuses on the greater Auckland area, encompassing Wellsford in the north, to Pukekohe in the south, and covers 500,000 hectares including coastal marine waters, with a 1600km long coastline. Although it houses almost a third of the population, the Auckland region is the smallest in New Zealand. The Auckland Regional Council is responsible for the area. The Auckland urban area covers about a tenth of the region, from Long Bay to Papakura. The remainder is mainly farmland and forests. Without careful management of urban development, however, the urban area could cover the area from Warkworth to Pukekohe within the next few decades.

3.1.2 Demand

Demand for aggregate is variable and cyclic and is influenced by the state of the national economy and number of large projects such as housing subdivision and highway construction. There is a baseline demand for aggregate that corresponds to a continuing need for road maintenance. Superimposed on this need are the requirements that are proportional to urban size and growth rates. Transecting all these requirements are special demands of major construction projects such as motorways and airports. Such projects often require large quantities of aggregate in relatively short periods of time. As such, major construction projects may significantly disrupt an otherwise predictable market. It is expected that Auckland aggregate demand will remain at 8 tonnes per person for the next 15 years, peaking at 9 tonnes per person (Whitehorn, 1999), (Christie, 2001), (Byers, 2003). Comparatively, national annual demand is estimated at 7 tones of aggregate per person.

An aggregate industry study in 1999 by S. Whitehorn examined the future demands and the resources available in the greater Auckland area. Her enquiries revealed customers were concerned with, in order of importance, three main areas (Whitehorn, 1999):

1. Price
2. Quality of personnel
3. Timeliness of contract schedule

3.1.3 Usage

Aggregates accounts for 90% by volume of civil engineering structures, such as roads and buildings, and accounts for approximately 30% of the cost of concrete. Construction and maintenance of roads are the dominant consumer of aggregate in Auckland (>50%), followed by the building industry (~30%) and lastly aggregate and clay for fill (~19%) (Table 3.1).

Figure 3.1: 1996 Auckland Aggregate Production (Christie & Braithwaite, 1999)

Aggregate Type	Mass
Decorative stone	312 050 T
Road Surfacing	8 029 T
Armourstone	794 011 T
Building	2 526 173 T
Roading	5 870 803 T

3.2 Potential Opportunities

Whitethorn's 1999 industry analysis determined the needs of the following industries: forestry (mainly in Northland and outside the target area), energy, dairy, airports, seaports, railway, telecommunications network providers, and water / waste network providers. A synopsis is provided below:

3.2.1 Roads

Transit New Zealand (TNZ) manages New Zealand's State Highways with funding provided by Transfund NZ according to their *National Roading Program*. The program outlines many capacity upgrade works to roads in the greater Auckland area – four lane highway developments north and south of Auckland and urban motorway and expressway improvements. TNZ offers performance based contracts, presently for 10 year maintenance contracts. Road reforms encourage a similar culture for future construction contracts (e.g. North Harbour Highway project) making way for innovative designs and use of materials.

<u>SH 1 Albany to Puhoi Northern Motorway Extension (ALPURT B2)</u>
The $300 million, 7.5 kilometre motorway will run between Orewa and Puhoi and is to be built between 2004 and 2008 involving the construction of twin tunnels, nine culverts and five bridges.

<u>SH 18 & SH 16 Upper Harbour Motorway</u>
This $250m project consists of 15 km of 4-lane highway, 6 major interchanges and a duplicate bridge across Upper Waitemata Harbour.

<u>SH 20 Puhinui Street Bridge to SH1 Manukau Motorway Extension</u>
A $100 million continuation of State Highway 20 motorway to connect with State Highway 1 motorway, involves 4kms of motorway with complex interchanges

<u>SH 20 Avondale Extension</u>
Connection of South-western Motorway SH20 with the North-western motorway SH16

3.2.2 Railways

The road and rail transport modes compete for both freight and passenger custom. There is a current drive by local, regional and central government to alter the balance between the two in the interests of alleviating Auckland road traffic congestion. The ARC is undertaking a major rail system enhancement and upgrade in partnership with Toll Rail (formerly Tranz Rail) and NZ Rail (The reappointed Crown track governing body). Proposals include of a 3km tunnel linking Britomart to Mt Eden, a harbour tunnel to the North Shore, and additional suburban and inter-city rail services linked to Britomart transport centre.

3.2.3 Forestry

Wood supply in Auckland region is of the order of 1.8 million m^3 per year. Storage at the Port of Auckland for log and wood chip exporting is minimal. The industry is currently facing a number of challenges including fallout from the late 1990's Asian Economic Crisis. The slump in the export log market necessitated supplying the market at largely reduced profits to gain cash flow for developing process plants to meet changing finished product demands. Once the plants were developed, and markets developed, forests were harvested without waiting for full growth. Although currently there are increased forest road contracts, over cutting will lead to a gap in mature trees in the near future.

3.2.4 Water/Waste Network Providers

As Auckland's Population grows so will the regions need for water. The Waikato River Water Supply Project goes someway to alleviate this. Metrowater (which provides water and wastewater reticulation in Auckland City) is spending $100s of millions to reduce pollutants entering Waitemata Harbour over the next 15 years (Whitehorn, 1999).

3.2.5 Seaports

Ports of Auckland are currently extending Axis Fergusson in a staged $110 million expansion.

3.2.6 Airports

Auckland International Airport Limited (AIAL)

The Domestic Terminal upgrade is regarded as non-urgent and is programmed to occur as airline requirements are confirmed. There is a long-term proposal to join the international and domestic terminals directly. The estimated remaining useful life of existing pavements is 11 years with the company focusing on rehabilitation and extensions to extend their useful life. Replacement pavement is in 500mm thick sections (previously 350mm). The construction of a second runway (figure 3.1) is "undoubtedly some years away" (Whitehorn, 1999). There is a planned budget in the order of $45 million per year for predominantly pavement construction.

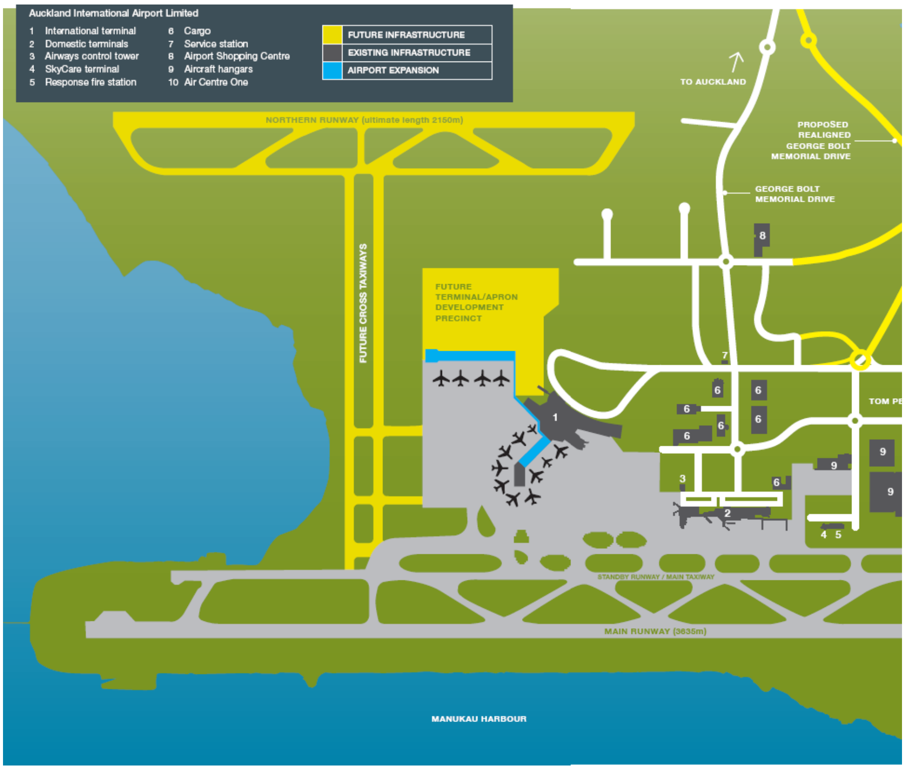

Figure 3.1: Plans for Auckland Airports Runway Duplication

Whenuapai Airport Development (ex-RNZAF Base Whenuapai)

Figure 3.2: Whenuapai Airfield

The New Zealand Defence Force is consolidating its airbase operations from Whenuapai in Waitakere City, to its Ohakea Airbase in Manawatu, by 2007. Plans to establish a second commercial airport for the region on the site are before cabinet. The strong support from the local community and interested airlines the proposal suggests it will become a reality with initial domestic flights being slowly introduced as the Air Force phases out operations on the site. The airbase consists of 311 hectares. There are three runways, but really only one is serviceable for commercial flights. This runs southwest-northeast with a length of 2031 metres and is the fourth longest runway in New Zealand. Although the runway was built in 1940, it is still in serviceable condition but will need some work in the medium term. The main runway can accommodate aircraft up to size Boeing 737 and 767s but it is too short for Boeing 747s. Ultimately it could be extended to a maximum possible runway length of 2,711 m. The airbase has capacity for 200,000 aircraft movements per annum. (AIAL Mangere has around 150,000 air movements p.a.).

4.0 Technical Considerations

New Zealand has a road network of approximately 100,000 km; of those 11,000 km are the State Highway system. This structure is supported by a population of only 4 million and has entailed that funds are scarce per length of road. The resulting form of pavement construction comprises of a carefully specified unbound granular base, supported as necessary on a lower quality unbound subbase (to further reduce costs); and surfaced with a one-coat or two-coat surface treatment. (Byers, 2003)

4.1 Product Specifications

There are four main distinct markets found in the aggregate industry; and their technical specifications along with quality requirements for another two distinct types found in literature and relevant to this project are detailed in table 4.1 below.

Table 4.1: Technical Specifications of Various Aggregate Types

Product	Usage	Specification:
Sealing Chip	For use on flexible pavement surfaces, New Zealand's predominant form of road surface treatment.	TNZ M/6: 2002 - Sealing Chip
Basecourse	Used as upper foundation material in road building.	TNZ M/4: 2003 - Basecourse Aggregate
Sub-base	Used as lower foundation material in road building.	TNZ M/3: 1986 - Sub-Base Aggregate TNZ M/22: 2000 - Guide to the Evaluation of Unbound Road Base and Sub-Base Aggregates
Concrete aggregate		NZS 3111: 1986 – Methods of test for water and aggregate for concrete NZS 3121: 1986 – Specification for water and aggregate for concrete
Railway Ballast		Track Specification # 140: 1999 Specification for the Supply of Crushed Stone Ballast.
Landscape / Decorative Aggregate		Various requirements, usually aesthetic and dependent on the exotic nature with regard to end use locality (e.g. rounded pebbles in an area with only hard rock quarries as an aggregate source).

4.2 River Bed Extraction Considerations

1. Establish the regeneration rate of the river (operation should be sustainable for 10 -15 years to be economically attractive).
2. Investigate grade (size) or aggregate: "you can't make small gravel bigger" (Whitehorn, 1999).
3. Consider site access, especially with respect to potential for erosion to river berms.

5.0 West Coast Situation

In terms of sediment movement within gravel-bed rivers, the West Coast of the South Island is one of the most active regions in New Zealand (Temple, 2001). The gravel-bed rivers on the Coast are dominantly sourced from headwaters in the Southern Alps and move westward to the coast on relatively steep gradients. High aggregate build up (aggradation) within a number of West Coast Rivers (e.g. Waiho River, section 6.2.2) presents major hazards. The region also has one of the lowest demands for aggregate material per head of population. This resource has the potential to be of high valuable to the future of the West Coast in terms of trade and employment.

5.1 Regional Overview

5.1.1 Geology of Greymouth Area

The West Coast area is bisected by the Alpine Fault, a major fault that forms the active plate boundary between the Australia Plate (to the northwest) and the Pacific Plate (to the southeast) in the central part of New Zealand (figure 5.1). The Southern Alps have been formed by movement along the Alpine Fault and rise from near sea-level to a maximum height of over 2200 metres. The mountains tend northeast and form a drainage divide, the main divide, between Canterbury rivers draining to the southeast and West Coast rivers flowing northwest. The region is rich in mineral deposits: over 70,000kg of gold have been extracted from quartz veins in the Reefton Goldfield and almost all the New Zealand's bituminous coal reserves (300 Mt estimated as recoverable) are found in the Buller and Grey coalfields (Nathan et al. 1986).

The area is subject to a number of hazards; with landslides, rockfall and especially flooding being ongoing hazards. Over the last 100 years there have been several large damaging earthquakes (magnitude 6.0 or greater) associated with the deformation of the Australian/Pacific plate boundary with epicentres within the region. The Alpine Fault is inferred to have ruptured as a result of large earthquakes events in 1717 AD, 1630 AD and 1460 AD (Yetton et al, 1998). The probability of major rupture on the Alpine Fault is estimated to be up to 20% in the next 20 years.

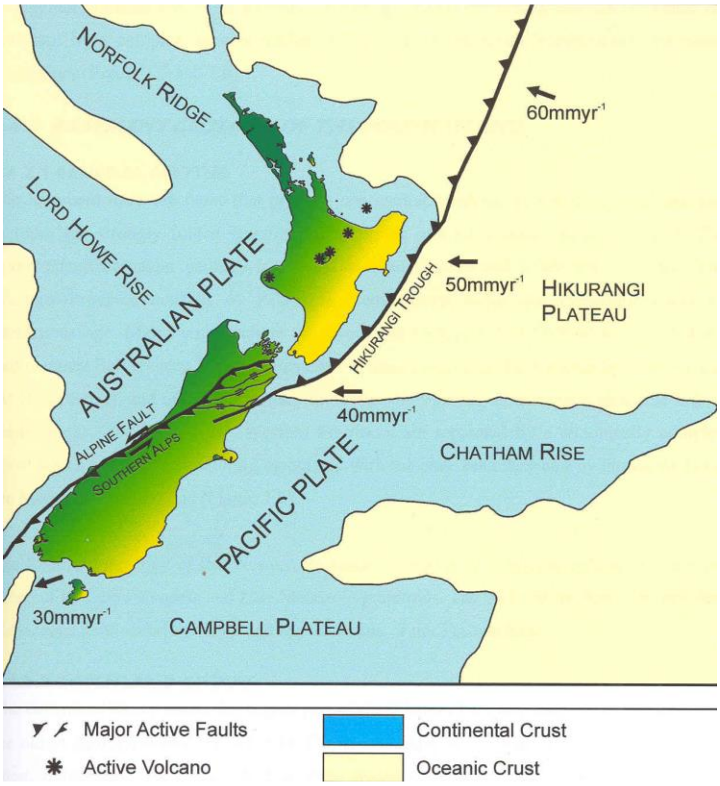

Figure 5.1: Tectonic setting showing the Alpine Fault boundary between the Australian and Pacific Plates with arrows indicating their relative movement.

A large, shallow earthquake often induces shaking related slope instability. Unconsolidated, fine grained deposits such as gravel are likely to show significant amplification of ground shaking during an earthquake. A number of such landslides were produced during the 1929 and 1968 earthquake events (Nathan et al, 1986). An increase in river aggradation and associated increased risk of flooding follow landslides of the earthquake induced scale. The overall smoothness of the West Coast sea floor reflects the deposition of large quantities of gravel bed load carried by the West Coast Rivers.

5.1.2 Climate

As the region is bounded on one side by the Tasman Sea and on the other side by the Southern Alps, the West Coast is subject to intense contrasts. The western range front of the Southern Alps is steep and high, and deflects the prevailing westerly air-stream upwards, resulting in periods of extraordinarily heavy rainfall (Table 5.1). The maximum rainfall recorded exceeds 10 metres per year in an area 3 – 5 km into the eastern catchments, and the rivers draining this area are often steep, deeply incised and prone to rapid flooding. Rainfall decreases westwards to less than 3 metres per year at the coast. The seasonal distribution of rainfall is very uniform with each season receiving close to 25%, although higher falls do occur during spring (September to November). Considering the latitude, the temperatures experienced in the coastal areas of the West Coast are surprisingly mild and very even. Summer days reach an average maximum air temperature of 20 ^{o}C with an extreme of 30 ^{o}C inland, with humidity around 80%, making for very pleasant days. Snow rarely falls on the lowlands and frosts are very mild on the coastal areas. Another significant feature of the regions climate is the relatively high number of sunshine hours per annum considering the high rainfall: Hokitika has 1890 hours/annum and Westport 1990 hours/annum.

Table 5.1: West Coast Mean Annual Rainfall (Temple, 2001)

Location	Catchment	Rainfall (mm)	Air Temperature (ºC)
Westport	Buller	2160	12.2
Reefton	Inangahua	2011	11.1
Greymouth	Grey	2447	12.1
Hokitika	Hokitika	2876	11.7
Ross	Totara	3336	N/C
Franz Josef	Waiho	5468	11.2
Haast	Haast	5752	11.2

5.1.3 Land use

Westland is sparsely populated with most people living in the coastal towns of Greymouth (10,000), Westport (4,600), and Hokitika (4,000). The territory administered by the West Coast Regional Council extends over a distance of 600km from Kahurangi Point in the north to Arawarua Point in the south, and is bounded in the east by the Southern Alps and on the west by the Tasman Sea (Figure 5.2). The territory covers an area of 23,000 km^2, which is 8.5% of the total land in New Zealand. Of the 23,000 km^2, only 11% is privately owned, and 87% is crown administered, with 78% of the total land area being Crown conservation estate and 21% being either fully or partly rateable (WCRC, 2004). The lower reaches of the rivers are extensively farmed. As covered in section 5.2, plantation forestry, coal mining and alluvial gold mining are also significant land uses. The upper slopes are used for forestry.

5.1.4 Local Authorities

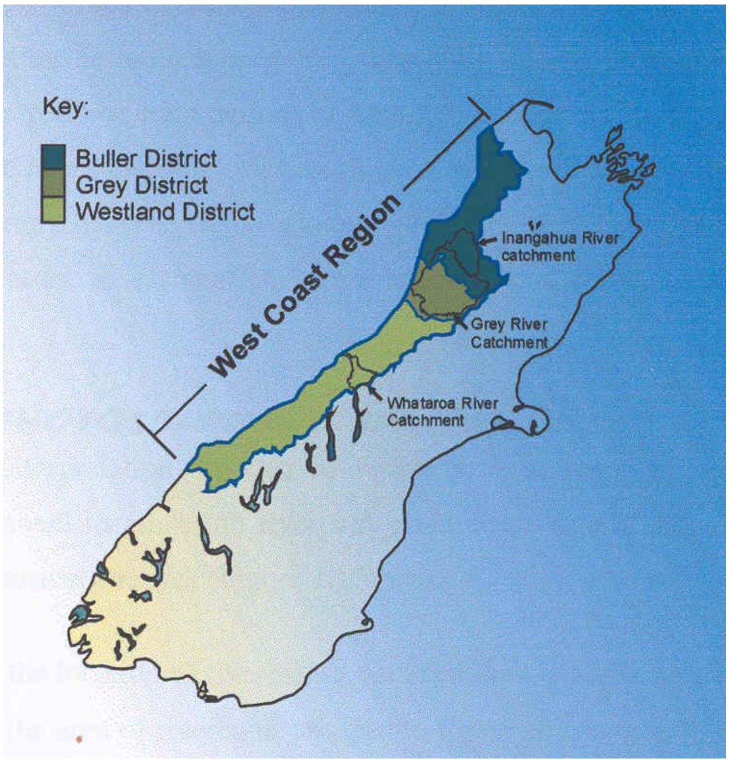

Figure 5.2: West Coast Local Authorities and their boundaries

The West Coast has four territorial authorities: There is the *West Coast Regional Council* (WCRC) who administer all the rivers in the green shaded regions in figure 5.2; then there are the 3 district councils, with their respective areas indicated in the aforementioned map: *Westland District Council*(WDC), *Grey District Council*(GDC) and the *Buller District Council* (BDC).

5.2 Industry

5.2.1 Coal

The West Coast Coal Region comprises 13 coalfields located in north Westland between Aratika, southeast of Greymouth, and Karamea. Virtually all New Zealand's bituminous coal occurs within the region.

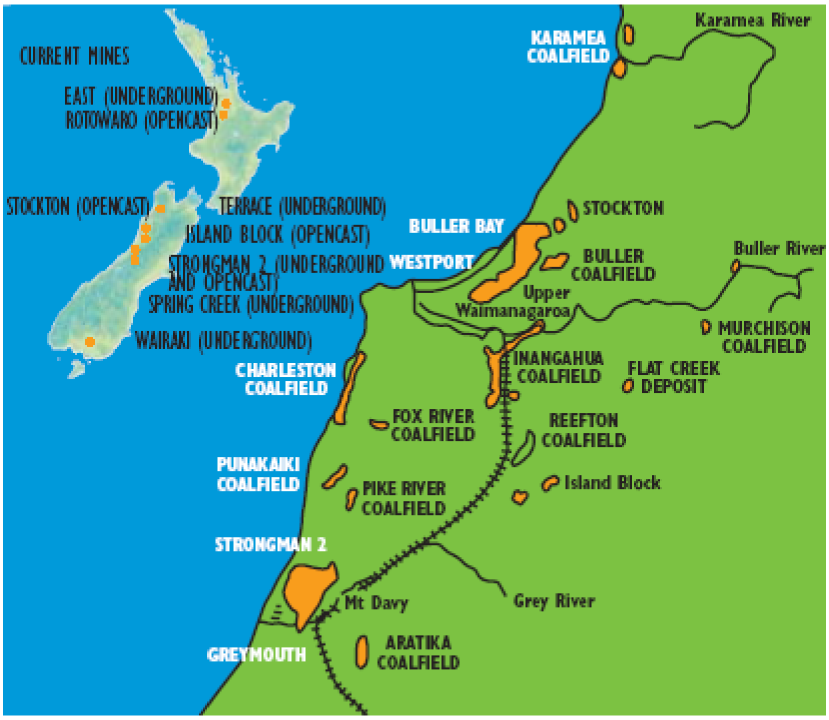

Figure 5.3: West Coast Coal Fields

Mining began in the West Coast Region in 1864, with mines opening in Greymouth and Buller coalfields, and prospered up to the 1920s, despite often difficult mining conditions. Production from predominantly underground mines declined during the depression years and after the Second World War, as many industrial and domestic consumers converted to electricity and liquid fuels. Large-scale opencast mining began in the Buller Coalfield in 1944 and opencast production has gradually increased over the last 50 years, replacing more costly underground production. West Coast coal is exported to 15 countries. (NZ Mining, v 30, 2001). Following a major fall in international coal prices in the late 1990s there has been a subsequent recovery in the coal industry (Table 5.3).

Total production from the region to date has been over 50 Mt (2001) with most coal coming from Greymouth and Buller coalfields. Recent annual production has averaged about 1.7 Mt, which was almost half of New Zealand's annual production, and all of its bituminous coal production. Over 80% was produced from opencast mines, mainly in the Buller Coalfield.

Most West Coast coal is exported via the port of Lyttelton, to meet the international demand for high-quality bituminous coals; it is also an important source of industrial and household fuel for the domestic market.

5.2.1.1 Coalfields

The total coal-in-ground resource for the West Coast Region is estimated to be 983 Mt, of which 343 Mt is considered to be recoverable currently (Barry et al. 1994). Greymouth and Buller coalfields contain the majority of the recoverable resource, having 47% and 34% respectively. Significant recoverable resources are also present in Pike River (8%), Reefton-Garvey Creek (4%) and Charleston (4%) coalfields. Current production comes from Buller, Greymouth, Reefton-Garvey Creek, and Inangahua coalfields, and mining is about to start on Pike River Coalfield.

Table 5.2: 1996 Coal Resource and Production Summary (Edbrooke, 2004)

West Coast Coalfield	Recoverable Coal Resource (Mt)	Annual Production (Mt)
Buller	118.4	1.10
Inangahua	5.9	0.07
Reefton-Garvey Creek	11.6	0.14
Charleston	12.9	-
Pike River	28.3	(Projected) 1.10
Greymouth	163.5	0.35
Aratika	-	-
Minor coalfields	2.7	-
TOTAL:	343.3	(2.76) 1.66
	Total NZ Production	3.50
	% of Total NZ Production:	(60%) 49 %

<u>Buller Coalfield</u>

The coalfield is New Zealand's largest producer of bituminous coal, with current annual production of about 1.1 Mt. Five mines operate within the coalfield, but more than 99% of production is from Solid Energy's *No. 2, Webb* and *Mt Frederick* opencast mines at Stockton in the western part of the coalfield.

<u>Greymouth Coalfield</u>

More than 100 mines have operated in Coalfield since 1864, producing more than 30 Mt to date from both Paparoa and Brunner seams. Most of the mining has been by underground methods and the generally unfavourable geological conditions offer only limited potential for future opencast mining. Seven underground mines are operating at present. Solid Energy's *Strongman Mine* is the largest producer, accounting for about 85% of Greymouth production. The new *Mt Davy* underground mine (on hold due to geotechnical problems, 2004) is planned to increase production by 0.5 MTPA.

Reefton and Garvey Creek coalfields

The largest producing mines are Solid Energy's *Island Block* Opencast (30 000) and *Terrace Mine* (25 000 TPA), and Francis Mining's *Echo* Opencast (45 000 TPA).

Inangahua Coalfield

Five mines work the coalfield. A much larger resource may exist in Inangahua Coalfield, as it remains relatively unexplored.

Pike River Coalfield

The coalfield is currently being developed by PRCC. It has not been mined previously due to its inaccessible location on the crest of the Paparoa Range, adjacent to Paparoa National Park.

5.2.1.2 Solid Energy NZ Ltd.

Solid Energy New Zealand Ltd is the New Zealand’s state state-owned company that operates as a “State Owned Enterprise”. Solid Energy plans to double its total production and sales to reach 6 M TPA by 2006, growing to a further 7 M TPA or higher by the end of the decade (Solid Energy, 2004). Solid Energy extracts, processes, markets and distributes around 3 MTPA of coal a year from its nine underground and opencast mine around Huntly in the Waikato, Greymouth, Westport and Reefton on the West Coast and Ohai in Southland. More than half of annual output is sold for export to major international customers who value the special low ash qualities of Solid Energy coals particularly in steel production as well as the manufacture of carbon fibre, activated carbon and silicon metal. The company’s core New Zealand customers are in the steel, electricity, dairy, cement manufacturing, meat and timber sectors. A further major customer is *Genesis*, owner of Huntly, New Zealand's only coal-fired power station which generates around 5% of the country's electricity. The two companies are investigating increasing coal use at Huntly Power Station to help offset New Zealand's potential electricity shortage. Industrial processing companies, including breweries and food manufacturers, along with the health sector are heavily reliant on coal for their energy needs. Solid Energy supplies coal for New Zealand Steel’s Glenbrook Mill.

Table 5.3: Recent Growth in Solid Energy NZ’s Production (Solid Energy, 2003)

Year	Export	Growth	Domestic	Growth	Total	%
2001	1.66 Mt	16 %	1.30 Mt	steady	2.97 Mt	6 %
2002	1.80 Mt	8 %	1.55 Mt	19 %	3.35 Mt	13 %
2003	2.13 Mt	18 %	1.96 Mt	26 %	4.09 Mt	22 %

In 2004, there is currently a boom in the Asian coal market, with strong demand for thermal coals prices are at a 20 year high (Table 5.3). Almost half Solid Energy’s export sales are to Japan. New deals have recently been struck with India’s largest private company Tata group and India’s largest integrated steel mill, SAIL (Solid Energy, 2004a). Solid Energy has been exploring (2003) option for increasing export capacity. In 2002 barging coal from Westport to Port Kembla in Australia resumed, with 50,000T exported by barge in 2003. The coal is blended with Australian coal and resold internationally primarily to Asia.

Figure 5.4: Typical West Coast Opencast Coal Mine

Spring Creek Underground

The mine is an underground operation near Greymouth and has replaced production for Solid Energy's Strongman 2 Mine, which closed in August 2003. Production is scheduled to be up to 800,000 TPA, double the output of Strongman 2. The recoverable resource is of more than 100 Mt of premium coal. The mine has potential to produce between 1.5 and 2 MTPA. (NZ Mining, v. 27, 2000)

Terrace Underground

Terrace Underground Mine is located on the northeast edge of Reefton township near the southern limit of Reefton Coalfield and had a long history as a private mine before being purchased by Solid Energy in 1988. Reefton is ideally located as a coal distribution centre, as it is on or near main roads to Blenheim, Nelson and Christchurch and adjacent to the main trunk railway line to Canterbury, as well as many smaller markets. Coal from the mine generally supplies South Island industrial customers.

Stockton Opencast

The mining operation, the largest in New Zealand, is located at between 500m and 1,100m above sea level in the Buller Coalfield. The current operation is located on an extensive, moderately undulating plateau. The area experiences high rainfall (around 6 m annually), cool temperatures, considerable cloud and mist, and occasional frosts and snow.

5.1.2.3 Pike River Coal Company Ltd (PRCC)

The Australian based Pike River Coal Company (PRCC) is 72% owned by NZ Oil and Gas Ltd and 28 % by private investors. It is currently obtaining consents to develop New Zealand's second largest export coal mine in the headwaters of the Pike River on the eastern slopes and crest of the Paparoa Range, 35 kms north of Greymouth. The $60 million development is expected to commence early in 2005. The company is proposing an underground mine with first year production of more than 500,000T would rise to approximately 1.1 MTPA by the second year continuing at this rate for 15 to 18 years, or longer. The coal will be mined by underground mining methods and blended with other coals to produce a high quality export coking coal. It is proposed that the coal will be barged / shipped from Greymouth to Shakespeare Bay, Picton, for loading onto super Cape-size vessels for export to overseas markets. Recent activities have been concentrated on obtaining land access from the Department of Conservation and securing new (largely replacement) resource consents.

Figure 5.5: Future PRCC Coal Mine

5.2.2 Cement

5.2.2.1 Holcim (NZ) Ltd

At Cape Foulwind, 10km west of Westport, a large lens of overlaying high-grade Waitakere algal limestone provides a feedstock for the Holcim (formerly Milburn) Cement works, together with smaller amounts of Marl from the lower part of the Kaitata Mudstone Formation. The limestone and clay occur together. It is necessary to drill and blast these materials before they are processed. The cement works has been operating virtually non-stop since it began operation in 1958. Running 24 hours a day the plant produces between 450,000T and 500,000T annually. Once processed into powder-like consistency it is trucked in silos to the Port of Westport or elsewhere for distribution. The silo units are loaded and unloaded pneumatically. Two ships, the MV "*Westport*" and MV "*Milburn Carrier II*" carry cement to depots at Onehunga, Wellington, Napier, Gisborne, Nelson, Lyttelton and Dunedin for distribution to customers (See section 11.5.1).

Figure 5.6: Holcim Cement Mine, Cape Foulwind with Westport in the left mid-distance

5.2.3 Gold

Gold mining has continued from one of the largest gold rushes in the world in the 1860s to the present day. Goldmines associated with quartz veins are mainly restricted to a north tending 10km wide zone in the Reefton Goldfield and its northern extension the Lyell Goldfield. This zone is where Oceana Gold (see below) intends open an opencast pit.

5.2.3.1 Oceana Gold

The Reefton Goldfield is located close to the town of Reefton, and is one of New Zealand's major historical goldfields. *Oceana Gold* holds tenements over a 35km north south strike length, covering the bulk of the known historical mines and prospects. The proposed operation comprises the an open cut development at Globe Progress Mine and an underground development at Blackwater Mine, located approximately 17kms apart. At full production in 2007, production from Globe Progress and Blackwater will be approximately 140,000 oz pa. It is expected that additional reserves will be defined. The viability of the developments at the Reefton Goldfield hinges on the reduced capital expenditure required through making use of spare capacity at the Macraes Goldfield autoclave in Central Otago. Mined ore will be processed into a concentrate at a 1.4MTPA capacity plant at the Globe Progress Mine producing approximately 95,000 TPA of sulphide concentrate. This will be transported 600 kms to Macraes for further treatment to extract the gold.

Globe Process Opencast Mine

Construction has commenced on the Globe Progress Mine with first gold to be produced in late 2005. Pre-production development costs are estimated at NZ$50million, including construction of the concentrate processing plant. Current reserves are sufficient to support a five year mine life at Globe Progress, but there is significant exploration potential to extend the open cut operations and target underground operations. A feasibility study completed on the Globe Progress Mine details the development of four open pits and the mining of 5.7 Mt of ore at 2.7g/t Au producing approximately 428,000ozs of gold.

Black Water Underground Mine

Blackwater Mine was the largest producing gold mine in the Reefton goldfield and was operational from 1906 to 1951. Underground mining was undertaken to a level of approximately 800 metres. Mining ceased when the Blackwater Shaft collapsed. Rehabilitation of the Prohibition Shaft has commenced for exploration and trial mining to define ore reserves. If successful, it is planned to commence development of an underground decline, approximately 3.6km west of the Prohibition Shaft with first gold to be produced in 2006. Pre-production costs are estimated to be NZ$26million. Mined ore will be transported at a rate of 0.11MTPA to the Globe Progress process plant where both ores will be blended and treated. The current inferred resource has the potential to support a seven year mine life. Deep surface drilling has confirmed that mineralisation extends to at least 200 metres below the lowest mined depth. A scoping study has been completed, involving the redevelopment of a narrow, high grade underground mine with an estimated diluted resource of 0.76Mt at 13.7g/t Au.

5.2.4 Forestry

Planted Forest Owners and Managers

Timberlands West Coast manages the Crowns 28,500 hectares of planted production forests which are mainly in the Grey district. Private operations include *Evergreen Forests Ltd* who have holdings of 1,700 hectares along with other firms with a total forest of 3,700 hectares scattered throughout the region (MAF, 2004).

Natural Forest

It is estimated that there are 82,000 hectares of privately owned natural forest in the region. There are currently five approved forest management plans covering 843 hectares, allowing for roundwood of 754 m^3 a year. There are 66 approved forest management permits covering 3,713 hectares with a 10 year approved harvest rate of 14,775 m^3 (roundwood) (MAF, 2004).

Sawmills

In 2001 approximately 83,000 m^3 of exotic sawn timber was produced (MAF, 2004).

5.2.5 Aggregate

Abundant supplies of aggregate are present throughout the region, almost entirely as gravel from present day rivers, old river terraces and locally from dredge tailings. The gravel commonly used on the Coast consists of granite and greywacke, with varying amounts of schist and gneiss depending on the source. From the Grey River south the dominant lithology in river gravels is Rakaia terrane greywacke. Rivers near main West Coast centres have continuous aggregate extraction from the river banks and approximately 165,000m^3 was extracted under resource consents in 1998 (Temple, 2001).

Table 5.4: West Coast Aggregate Production (Crown Minerals, 2004).

tonnes	**Roading Aggregate**	**Building Aggregate**	**Decorative Pebbles**	**Total (t)**
1990	69,000	14,000		83,000
1994				80,000
1999	162,000	9,000		171,000
2002	194,650	27,350	5,000	227,000
2003	227,920	26,820	4,250	258,990

5.3 Infrastructure

5.3.1 Ports

The region has no deep water ports, but has river mouth ports at Greymouth and Westport. Historically both have handled coal and timber and, for Westport, cement. There is a remote fishing port at Jackson Bay in the south of the region. A brief history of ports on the West Coast is given in Appendix 1.

5.3.1.1 Port of Westport

The Port of Westport is owned by the Buller District Council and managed under contract by Holcim NZ Ltd (the principal port user) through their subsidiary company, Buller Port Services Ltd. The port has a tug/pilot vessel and a dredge. There is one electric travelling crane with a 12.2Tlift and a 17 m radius, and mobile cranes available. A merchandise shed has a storage area of approximately 3500 cubic metres and there is a flat storage area of 20,000 m^2. The port is served by road and rail transport.

Figure 5.7: Port of Westport

The bar can extend up to half a nautical mile off the entrance. Bar conditions are a function of:

- The **run** in the river
- The **set** (cross current) at the entrance
- **Swell** size and direction
- **Wind** and **sea** conditions
- Available **depth** of water (determined by tidal height and position of sandbanks)

Swells up to 4 metres are not uncommon. Set and breaking swells are considerably reduced at the top of the tide. Incoming tide is preferable to cross as there are no pressure waves at the entrance. The bar is sounded twice weekly and the port needs to be dredged often.

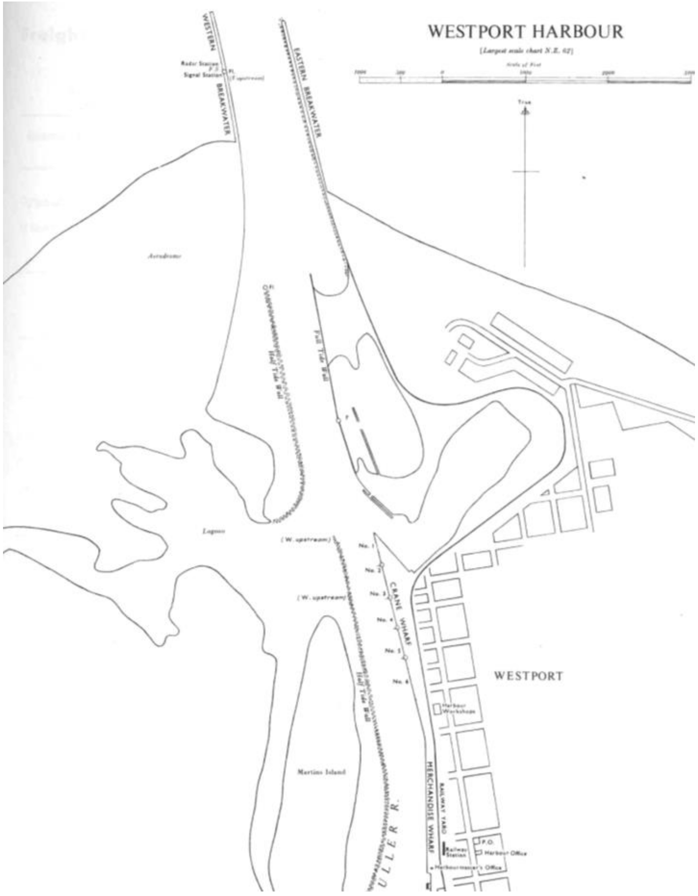

Figure 5.8: Map of Westport Harbour

The port exports up to 500,000 tonnes of cement per year to domestic and South Pacific markets. Coal is the other major export product and is shipped aboard by barges of 8000 and 12 000 tonnes to Port Kembla (NSW, Australia), with smaller cargoes of 4000 tonnes going to Whangarei. Coal is loaded via a new 2000 tonnes per hour load out facility. It is expected that timber will become a future cargo being shipped to Shakespeare Bay for onward export (see section 11.6.1). Imports are gypsum, furnace slag and some very heavy mining machinery. A cruise liner makes annual calls. Vessels up to 135 metres long and 5.5 metres average draft can be handled, with large vessels considered as each case is presented.

5.3.1.2 Port of Greymouth

The Port of Greymouth is situated at the mouth of the Grey River, is owned by the Grey District Council and managed by Port of Greymouth Management Ltd. The port is able to handle vessels of up to 109 metres length overall, and draughts of up to 4.8 metres (neap tides) or 5.5 metres (spring tides). This equates to ships or barges up to 8,200T capacity (see table 5.5). A deadman enables vessels up to 10,000 DWT to be held in port. A maximum dept at berth of 5.5m is obtained by dredging and one months notice of draught in excess of 3.5 m is required to arrange dredging if necessary.

Table 5.5: Largest Vessels Accommodated at Port of Greymouth

Quantity	Vessel	Year	Measurement
Loaded Draft	SS Omana	1948	6.3 m
Load	Sea-Tow 4, (2001)	2001	8,134 t
GRT	Sea-Tow Tug 25 & Sea-Tow Barge 4 combined	1998 - 2004	4,056 t

Figure 5.9: Port of Greymouth

Cargo can be loaded by two wharf cranes of 12 tonne lift capacity each, by additional hired mobile cranes, or by ships' cranes. Cargo handling services are provided by T Croft Ltd and an 800 to 1000 mobile conveyor/loader owned by Sea-Tow Ltd can be leased. There is 1,500 m^2 undercover storage and open storage capacity of 20,000T from bulk coal, 4,000T for aggregate (capacity leased to Sea-Tow Ltd, but available to other shippers by arrangement). An additional 2700m^2 is available for aggregate within 100m of operational wharf. Wharves adjacent to this area could be used with strengthening. An additional 3Ha is available for development within 500 m of wharf. The advent of the deepwater berth at Shakespeare Bay, Port Marlborough, has opened the opportunity for a coastal service from Greymouth (268 nautical miles) for transhipment to up to Cape-size vessels. This will be a particular advantage for coal and might also offer opportunities for timber, logs and wood chips. The port is served by road transport, with the railway one kilometre away.

Table 5.6: Port Distances from the Port of Greymouth

Port	Distance
Nelson	240 nm
Shakespeare Bay - Picton	268 nm
New Plymouth	251 nm
Port of Onehunga	380 nm
Sydney	1075 nm

There is an inner and outer bar at Greymouth but depths over the inner bar generally control. The bar usually consists of sand. Historically, as the breakwaters have been extended the bar depths have been affected. Initially after construction the bar abates, but gradually the south shore builds out and the bar returns. Generally the bar builds up in moderate weather and absence of flow surges in the river. Rough seas and floods in the river clear the bar, but at such times shipping may be held up by breakers at the entrance. Southwest wind and swells can be a problem for the river port and ships delayed 22 hours on average.

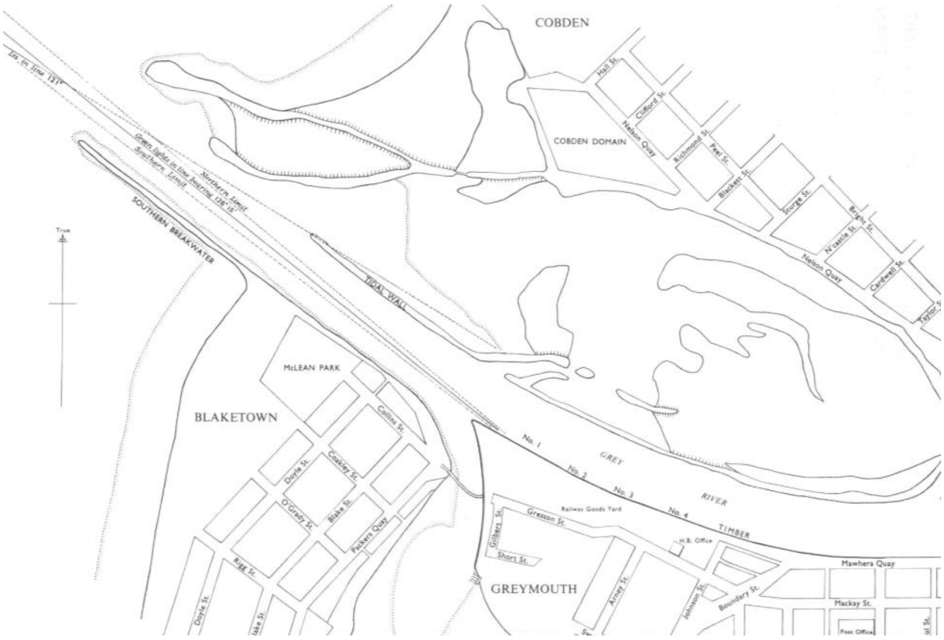

Figure 5.10: Map of the Port of Greymouth

The port ships about 85 000 tonnes of coal per year in 4,000 and 8,000T capacity barges to Whangarei and New Plymouth, and about 12,000 tonnes of aggregate per year in 4,000 tonne capacity barges to Onehunga. Company forecast and current tonnages are given in table 5.7.

Table 5.7: Port of Greymouth Current Actual & Projected Tonnages

	Coal	Aggregate
Actual 2003-04 tonnage	62,639 t	1,007 t
Projected 2004-05 tonnage	400,000 t	27,000 t

Sawn indigenous timber was a traditional export to Australia until the 1950s and to the North Island until the 1970s. In 2000 timber shipments to Australia resumed with four shipments of processed plantation timber directly to Yamba (northern NSW) for the Brisbane market. The trade ceased with the downturn in the Australian market, but direct shipments are expected to recommence as the market improves. The port provides timber receiving, storage and stevedoring services. Storage is available for 1,000 m^3 of dry timber in cargo sheds, and about 5,000 m^3 of timber or logs alongside the wharf. An additional 4 Ha of land is available nearby for outside storage. Fumigation can be arranged. The Sea-Tow conveyor/loader is probably able to load wood chips.

5.3.1.3 Jackson Bay

Westland District Council owns and has responsibility for inspection and maintenance of the Jackson Bay Wharf. The wharf provides a base for fishing boats, and is a hub for lobster landings in the region. On shore there are storage facilities for fish and equipment. The bay is a natural ocean harbour (figure 5.11a) sheltered from the prevailing winds.

Figures 5.11a & 5.11b: Jackson Bay (Left) and Wharf (Right), 2002

5.3.2 Rail

The West Coast connects to the national rail network operated by Toll NZ via the Midland Line through the Otira tunnel at Arthur's Pass. This network (comprising of 300 kms of track) goes to Ngakawa past Westport in the north and to Hokitika in the south. There is no rail link to Nelson.

Figure 5.12: Coal train north of Westport

The railway is the main mode utilised presently for the transport of bulk products like coal, timber, dairy and meat products. These bulk products are usually railed from The West Coast to the Port of Lyttleton where it is then shipped either to other destinations within New Zealand or to the overseas markets. Being a high capacity track, the rail system on The West Coast has the potential to carry 5 MTPA of goods. However, in 2003 Tranz Rail was only able to achieve an operating performance of 84% for the West Coast to Lyttleton Midland Line (Solid Energy, 2003). This was attributed to the condition of track infrastructure, speed restrictions imposed on several bridges due to deferred maintenance and locomotive unreliability and in June 2004, reports indicated that the Midland Line would not be "fit for use" without $70 million worth of maintenance and upgrading. In September after becoming track owners, New Zealand Rail Corp. ("TrackCo") made $25 million immediately available for maintenance on the line (Hartley, 2004).

5.3.3 Road

The West Coast is served by 873 kms of totally sealed State Highways (figure 5.13). Local roads comprise of about 2,010 km of which 50% are sealed. The Coast is linked to Canterbury by State Highway 73 through Arthur's Pass or State Highway 7 through the Lewis Pass. State Highway 73 offers a shorter route (247 kms vs. 334 kms) from Westland districts to Canterbury, but suffers from frequent natural and geological hazards. The province is connected to Otago by road via State Highway 6 over Haast Pass.

5.3.3.1 State Highways

The lack of a railway or an alternative road route south of Hokitika makes State Highway 6 particularly significant. State Highway 7 serves mostly the northern part of the region. It is utilised by those vehicles that are unable to negotiate the Otira Gorge. State Highways 65 & 69 connect with State Highway 6 leading to Nelson. State Highway 6 provides access out of The West Coast to the northern part of the South Island whereas State Highway 67 provides internal access to the northern part of the region (Karamea). While the total volume of trade with the northern part of South Island is not as large as with the Canterbury region, the lack of a railway line from The West Coast to Nelson and Marlborough means that there are high volumes of freight on these roads including coal, timber, fish, sphagnum moss and fuel. They also provide a conduit for those visitors seeking access into and out of the region from the northern part of the South Island. State Highways 6, 65 and 7 via Murchison and the Lewis Pass provide the shortest Nelson to Christchurch route.

5.3.3.2 Local Roads

The local roads serviced and maintained by the Westland, Grey and Buller local territorial authorities. Significant local arterial routes are Stillwater-Jackson’s, Coal Creek - Ikamatua, Haast - Jackson Bay and Ngakawau-Karamea. Roads within the region are troubled by rough and unsealed roads, substandard heights, over dimensional restrictions (both in terms of height & width), single lane bridges and narrow winding roads. State highway and local authority roads are generally adequate for use by loaded trucks (MAF, 2004).

Figure 5.13: Westland’s State Highway Network

6.0 Supply

6.1 New Zealand Aggregate Resource & Extraction

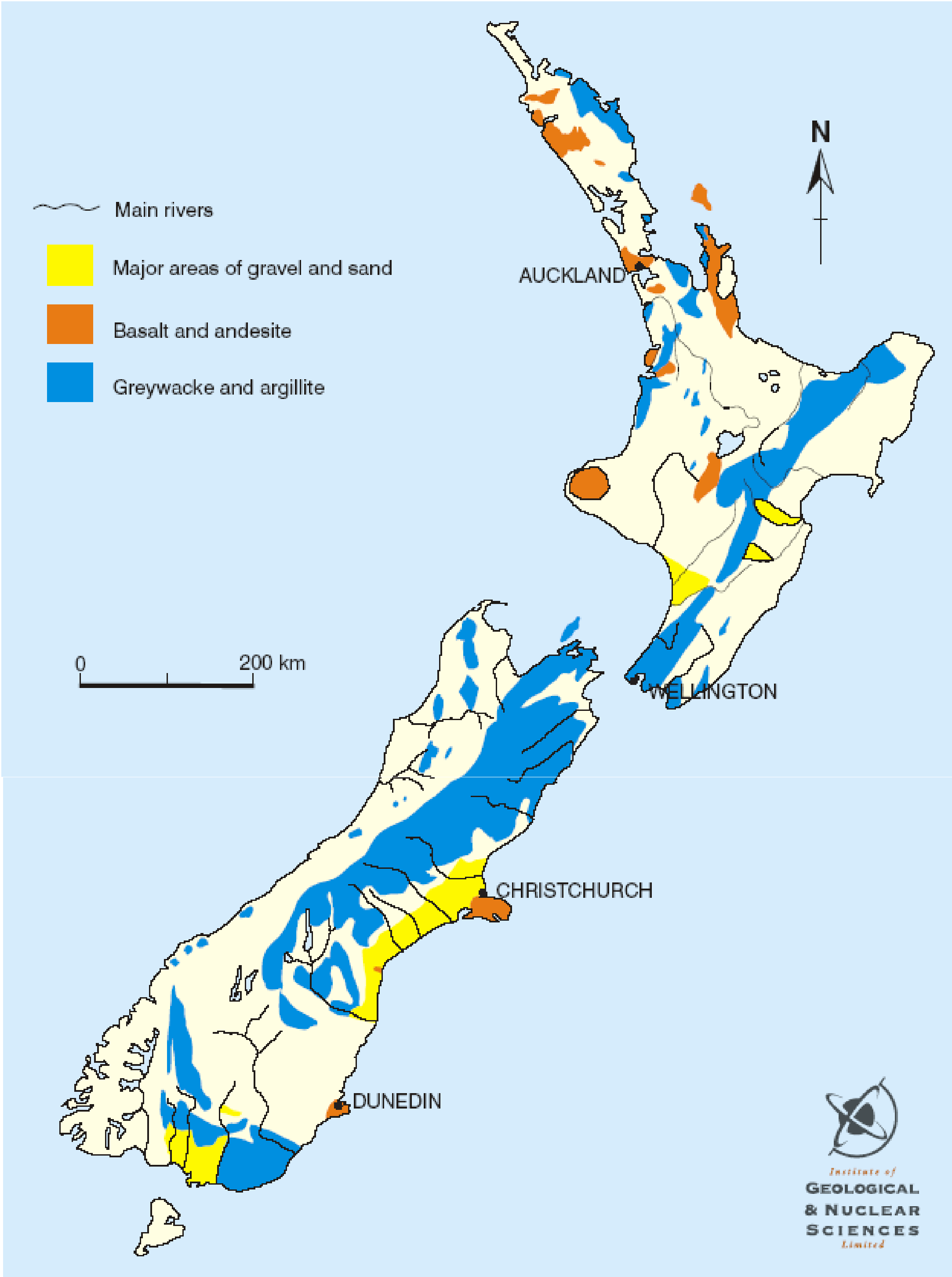

Figure 6.1: Map of New Zealand's Aggregate Sources

Domestic production of aggregates and sand in New Zealand is 20.5 MTPA with a value of the order of $250 million. The industry is dominated by a small number of major companies, but there are a large number of small producers who meet local demand. The most important rock types used for high quality aggregate are greywacke sandstone, basalt and andesite.

Basalt and andesite are quarried, and greywacke is either quarried or won from alluvial gravels. Quartz sand and gravels are also widely used or aggregates for concrete and masonry. In areas devoid of suitable rock types, limestone is commonly used. In the most difficult area around Gisborne, hard coquina limestone has been quarried for road metal. In part of the Wanganui basin, much of Eastern Taranaki and the southern part of the King Country are underlain by soft sediments. In the early years of settlement some roads in the region were paved with baked siltstone (burnt papa) made by firing the rock in roadside pits with wood from nearby forests as fuel (Williams, 1974). Most regions in the North Island are serviced by numerous rock quarrying and/or river gravel extraction operations .It is now possible to transport high quality product by road and rail throughout the North Island. Winstone Aggregates employees a full-time aggregate logistics co-ordinator, Doug Goodwin, especially for moving specialty material about the country (e.g. sealing chip to Gisborne) (Wortman, 2004) (McSaveney, 2004).

6.1.1 Alluvial River Channel Extraction

Numerous rivers are mined for aggregate around New Zealand, many with a replenishment rate that threatens built infrastructure and land through the reduction in river channel sectional area and the prospect of flooding. The greywacke siltstone found in the Toulouse Super-group (figure 6.5), characteristic of the east coast of both the North and South Island is ideal for all aggregate uses. Such rivers can be found in Hawkes Bay (Waipawa, Tukituki and Ngaruroro Rivers), and Canterbury (Hurunui, Waimakariri, Ashburton, North Ashburton, and Rakaia Rivers).

6.1.2 Pit Quarrying of Alluvial Fans and Flood Plain Terraces

The Canterbury Plains and the Heretaunga Plains (Hawkes Bay) are extensive alluvial floodplains. The greywacke is often mixed with silts and sands and the necessary washing adds cost and creates dust. In Hawkes Bay the bulk of this resource has in recent times been sterilised due to it also being prime wine growing land. The aggregate could be trained or trucked to the Ports of Lyttleton or Napier and then barged either to the East Coast or West Coast of Auckland. In the UK so-called “coastal aggregate” is won from “super quarries” and transported via barge to cities (Section 11.3).

6.1.3 Hard Rock Quarrying

The Hunua ranges, Bombay, Franklin and Waikato area are speckled with volcanic domes and cones, with medium to highly weathered basalts and dacite. Quality andesite flows and dykes are situated between Tauranga and Waihi, close to rail heads and the Port of Tauranga for barging. The northern tip of East Cape is a possible source of high quality aggregate. Extensions to the nearby Hicks Bay jetty in partnership with the burgeoning timber industry would provide a savoury deep water port suitable for use by large aggregate vessels (Ross, 1977).

6.2 West Coast Aggregate Resources

The West Coast region is characterised by its large number of major rivers flowing steeply to the sea with riverfan formations in the lower reaches. There is significant long-term (100 + years) movement of sediment which replenishes from fan and tributary sources and episodic input from storm and earthquake events. Most erosion and transport of gravels by rivers occurs during floods caused by torrential rain, rather than by stream flow from melting ice.

Figure 6.2: High flow event resulting in high sediment transport in a West Coast river.

Abundant resources of aggregate are present in the Westland area, particularly as easily worked gravel deposits in the following settings:

1. modern river and stream channels and banks
2. Interglacial aggradational river terrace deposits (Buller, Grey, Arnold, Taramakau, Hokitika)
3. Glacial outwash and till deposits
4. Raised interglacial beach deposits along the coastline
5. tailings from placer gold workings

Riverbed and beach deposits are extracted by loader. Terrace deposits require stripping and possible ripping with a bulldozer before removal with a loader. Crushing is required for shaping and sizing of concrete and road building aggregate.

6.2.1 Literature Review

A major study of the aggregate resources of the region was commissioned by the West Coast Regional Council and undertaken in 2001 by University of Canterbury M. Sc. Candidate Stephen Temple. The findings of this thesis entitled "Investigation and Management of Aggregate (Gravel) Resources West Coast NZ" (Temple, 2001) relate emphatically to the enquiry of this project and as such are paraphrased below:

6.2.1.1 Thesis Overview

The aims of the were to evaluate three typical river systems of the region, namely Grey, Inangahua, and Whataroa Rivers (figure 6.1) to determine the aggregate resource in terms of quality, quantity and potential environmental effects that extraction would have; and to assess whether current management practices were sustainable. A list of all the rivers with a history of gravel extraction within the region was tabulated against known site geological, hydrological, conservation, and recreational information (Table 6.1). The rivers were selected as they represented the main types of lithology combinations that are transported by the regions rivers, enabling results to be used to assess suitability of similar rivers (figure 6.3).

Table 6.1: West Coast River Data

Rivers	Present Consents	Sensitive Sites	DOC Land	Cross-Section	Flow Data	Source	Catchment Area (km²)	Rainfall Data	Geology
Large (1000km²)									
Buller River	✓	F/D	✓	WN	W/N	M	6350	✓	G
Grey River*				WN	W	H-M	3830	✓	GW
Haast River	✓	F/D	✓	W/N	W/N	M	1020	✓	G
Inangahua River*	✓	F		W	W	H-M	1000	✓	G
Karamea River	✓	F/D	✓	W	W	M	1160	✓	GW
Medium (100 - 1000km²)								□	
Arahura River	✓	F		W	W	H-M	288	✓	S/GW
Kokatahi River		F		W	W	M	159	✓	S
Taipo				W/N	W/N	M	181	✓	S
Taramakau River	✓	F/D	✓	W	W	M	863	✓	GW
Whataroa River*	✓	F/D	✓	WN	W/N	M	445	✓	S
Small (<100km²)								□	
Cropp				W/N	W/N	M	12.2	✓	S
Pattinson Creek				W/N	W/N		0.82	✓	G
Sirdar Creek				W	W	M	0.2	✓	GN
Styx				W	W	M	62	✓	S
Tiropahi				W/N	W/N	H-M	36.5	✓	GN

Key: D = Department of Conservation, **F** = Fish & Game, **N** = National Institute of Water and Atmospheric Research (NIWA), **W** = The West Coast Regional Council (WCRC), **WN** = WCRC and NIWA, **M** = mountain fed (snow and glacial), **H** = hill fed (spring), **G** = Granite, **GN** = Gnesis, **GW** = Greywacke, **S** = Schist, ***** = selected river

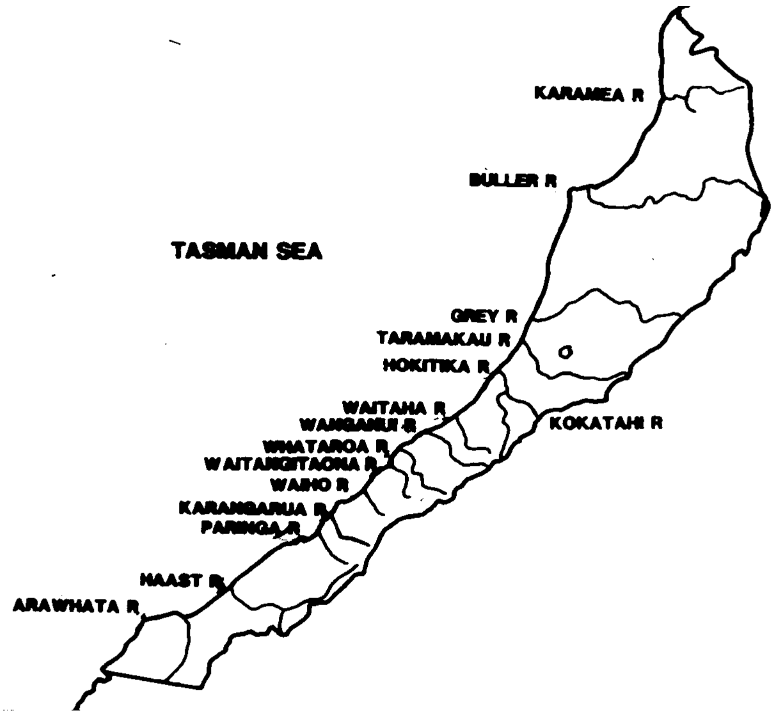

Figure 6.3: Rivers of the West Coast Region

Figure 6.4: Location of river catchments investigated and analysed by S. Temple in 2001 (Map taken from Temple, 2003)

6.2.1.2 Inangahua River

The river is characteristic of upper West Coast region rivers, where headwaters lie on the western side of the Southern Alps with gravels being Tuhua Granite and Greenland Group (figure 6.5) in equal proportions. It is one of the major tributaries of the Buller River.

The principal sources of sediment within the Inangahua River are:

- Erosion of the river banks, especially in the lower reaches downstream from Reefton.
- Bed mobilisation and transfer due to fluvial entrainment under high flow regimes
- Sediment sourced from tributary streams and fans (e.g. Waitahu and Larrys Rivers).

The upper catchment sources of sediment are reworking of Speargrass outwash gravels on the broad open valley floor (principally a 10 km stretch above Garvey Creek Junction). There is a restriction to sediment transport in the gorge section formed in Greenland Group rocks that outcrop between Blacks Point and Reefton, high discharges are needed for significant sediment quantities to be transferred to the lower catchment. The lower catchment from Reefton to Inangahua Junction consists of a series of gravel terraces overlying bedrock. (young Speargrass outwash gravels). Over a 20 year period there was a loss of 16 Ha of riparian land in the lower catchment due to erosion on the eastern bank showing that an unknown quantity of sediment transfer has occurred over the period. Current extraction volume of 2500m^3 was considered sustainable, however before increasing extraction quantities further profile measurements and analysis should be undertaken. The river has 40,000m^3 estimated bedload sediment.

The aggregate material from the lower catchment (Reefton to Inangahua) is suitable for all specifications evaluated. Owing to a high abrasion value, the Craig’s Clearing material does not meet railway ballast specifications.

6.2.1.3 Grey River

The Grey is typical of the rivers of the central part of the West Coast, where the headwaters lie on the eastern side of the Alpine Fault and the dominant geology is Greenland Group as well as Haast Granite (figure 6.5).

Significant replenishment of the Grey River occurs from erosion and reworking of Otirian Glaciation outwash gravels (especially the lower Loopline and Speargrass outwash terraces). Sediment transfer is limited by a rock outcrop between Stillwater and Dobson, meaning extreme discharges are needed for replenishment (exceeding one year flood). Other sources of gravel for the river include erosion of younger riverbank floodplain deposits, sedimentation from tributaries and local fan sources and associated bed mobilization and transfer due to fluvial entrainment of material during high flow events. Sediment pulses from the upper catchment (headwaters to Stillwater) derived from large sediment storage areas upstream of Stillwater-Dobson gorge section occur during high flow discharges and are transferred into the lower catchment (Dobson to river mouth). Substantial volumes (10 – 100m^3 per event) of sediment are being transported through the lower catchment river by 10 -12 high discharge events per year. This means that volumes equivalent to that already granted by resource consent can continue to be extracted within minimal effect on the lower river system. On the whole sediment sourced from the main tributaries in the central section of the river had no significant effect on the position of the river, which suggests that erosion and removal approximates sediment supply. The Grey River has 60,000m^3 estimated bedload sediment.

River gravels were found to be suitable for all tested aggregate specifications evaluated (TNZ Roading and Sealing Metal Specifications, Concrete). One sample did not meet all the tests for Railway Ballast.

6.2.1.4 Whataroa River

The Whataroa is representative of the majority of rivers from Hokitika to Haast Pass, with headwaters located within the Southern Alps and with the dominant geology consisting of schist graded from garnet to chlorite sourced from the eastern side of the Southern Alps.

Significant replenishment occurs due to weathering and transfer of sediment material from higher slopes and fans, especially the Alpine Fault-controlled range front. Principle sources of sediment identified were:

- Upper catchment slope and relict glacial deposits
- Active fans from the Alpine Fault-controlled range front accumulating sediment from the higher slopes and building outwards,
- Episodic generation of new material accompanying Alpine Fault rupture events and associated ground shaking approximately every 250 years.
- Erosion of the river banks
- Bed mobilisation and transfer due to fluvial entrainment of bed material under high regimes.

Channel migration has resulted in a loss of 230 Ha of riparian land to erosion, confirming that the primary sediment source of the lower catchment is the active fans that have built up from sediments supplied by streams (Dry Creek, Law Creek and McColloughs Creek) that flow from the southwest face of the Mt Adams Range, with most of the sediment transfer occurring during major rainstorm events. Current annual removal rate of 2,500m^3 is considered realistically sustainable. Additional aggregate supplies could be found on the braided section of the Whataroa Reach such as off the end of Whale Road. Extraction above the old State highway bridge is not feasible without detailed monitoring to observe effects of extraction on the active debris fans and to armouring of the river bank. The Whataroa River has 50,000 m^3 estimated bedload sediment.

The material gathered from the gorge showed that it is not suitable form railway ballast or sealing chip. Furthermore, the high percentage of mica present within the schist material and the associated potential for weak cement-aggregate bonds means that it is not entirely suitable for use as a concrete aggregate.

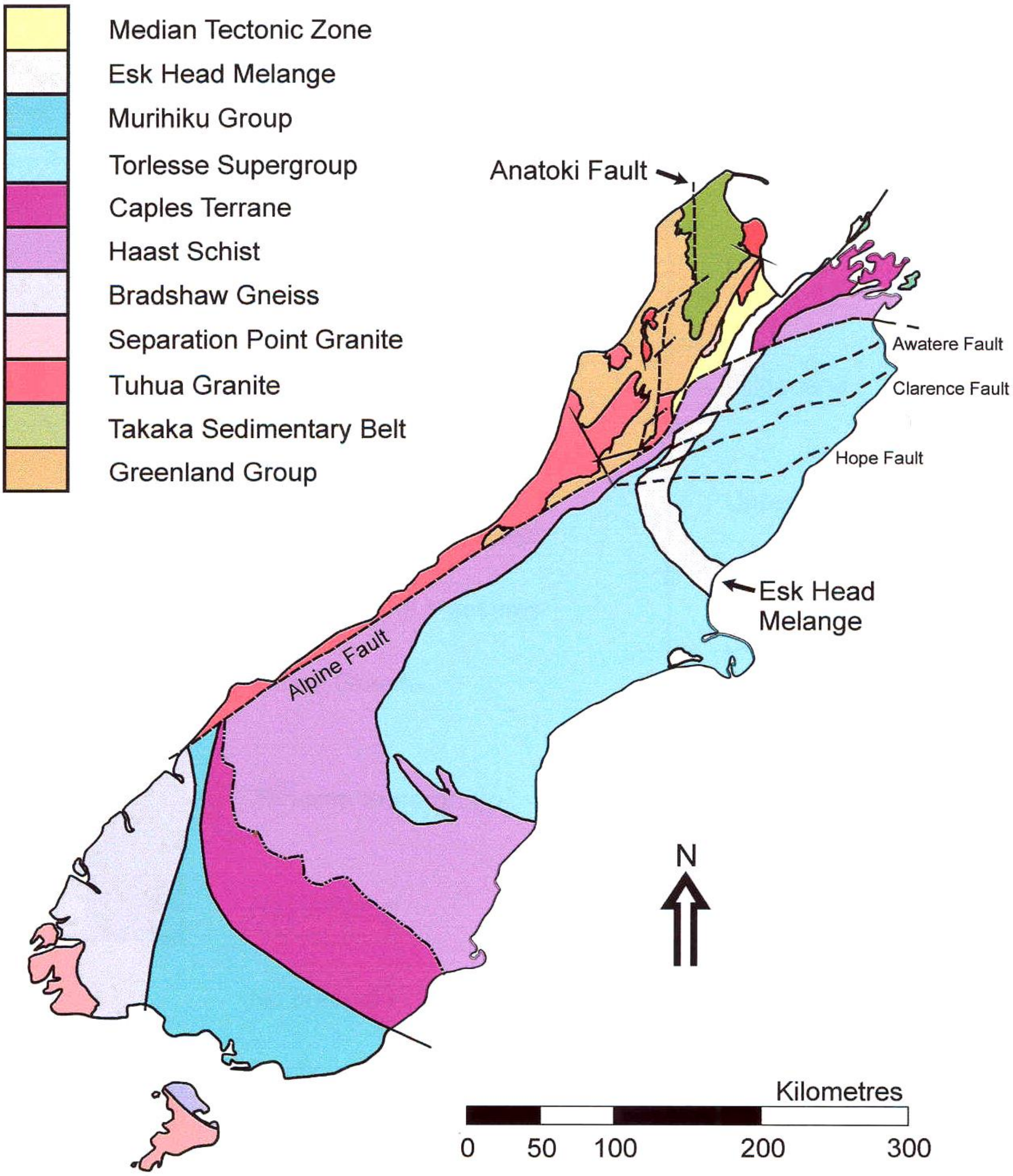

Figure 6.5: Simplified Geological Map of the South Island indicating the main geological units and structures (Taken from Temple, 2001)

6.2.1.5 General Conclusions

1. Material with a high proportion of Greenland Group and a low degree of weathering is suitable for use in all the current specifications evaluated.

2. Greenland Group with a moderate to high degree of weathering is not suitable for use as sealing chip and railway ballast. (Due to the need for low abrasion loses).

3. Equal portions of Greenland Group and Tuhua Granite are suitable for use in all the specifications evaluated, so long as it has a low degree of weathering (not sourced from the older weathered glacial terraces).

4. Aggregate consisting of schist is only suitable for use as basecourse, unbound road base and sub-base and concrete. (High proportion of micas will breakdown under intense periods of high abrasion due to weak bonds between mica crystal lattices).

5. The amenable Greenland Group sandstone with low degree of weathering are sourced from both the Grey and Inangahua catchments, and are indicative of the general quality of aggregate materials available in the central and upper West Coast rivers.

Table 6.2: Aggregate Quality of Three Representative Rivers

	Inangahua River	Grey River		Whataroa River
		Lower Catchment	Upper Catchment	
Sealing Chip	✓	✓	✓	×
Basecourse	✓	✓	✓	✓
Unbound road	✓	✓	✓	✓
Concrete	✓	✓	✓	✓
Railway Ballast	✓	✓	×	×

6. Substantial sediment storage is occurring in parts of each catchment, especially the Grey River where large quantities have been accumulating above Stillwater due to bedrock gorge restricting throughput. This is also shown in the Inangahua River, where a gorge has formed on the Black’s Point section of the river and as a result it appears that sediment transfer at both locations is not occurring rapidly or continuously.

7. There is no indication that current extraction of bed load material is having detrimental effect on the river environment and in terms of replacement the Grey and Whataroa are at least matching present extraction rates. Data suggested that minimal replenishment was occurring in the Inangahua River and that this requires careful management. Monitoring of key extraction sites would enable an adequate understanding of bedload movement patterns; this is especially pertinent if current extraction rates from the active floodplains are increased significantly for any of the rivers. There is, however, no evidence from the profile surveys that net gains or losses are occurring. An alternative is to extract from the storage areas on the river systems, with extraction and processing occurring on a campaign basis and monitoring to confirm recovery of bed profiles.

6.2.2 Waiho River

192 km north of Jackson Bay and 179 km south of Greymouth, the River is a steep high energy gravel bedded river that drains from two subcatchments, the Callery and that which contains the Franz Josef glacier. Fluctuation in sediment transport and storage is attributed to extremes of rainfall, landslides, earthquakes and glacier burst (Turnbill, 1998). The Waiho-Callery catchment drains 170 km^2 of the Southern Alps, where tectonic uplift is rapid (3m in 300 years) and rainfall is high (14 m per year, 600 mm per day is common). The head of the gravel fan has been aggrading rapidly for half a century, creating an associated flood risk to the fan head village of Franz Josef Glacier and its environs (figure 6.6a). The aggradation has in recent decades repeatedly damaged river-control works and reduced the effectiveness of flood hazard mitigation. (Section 6.6b) State Highway 6, a tourist corridor is frequently interrupted where it crosses and runs adjacent to the Waiho River. Aggradation at the State Highway bridge amounted to 5 m between 1985 and 1999 (Davies, 2002). Much of the local economy is tourist dependent and closures in the high season can imply losses of $1,000,000 per day (Turnbill, 1998). Closures of up to 5 days are not uncommon events (as in December 1995).

Figure 6.6a & 6.6b: Left: Waiho River stopbanks higher than roofs of Franz Josef village; Right: Erosion caused by high flow events in Waiho River

Temporary blockages or changes in the glacial drainage system create brief floods that expel large pulses of sediment; one such event in December 1995 deposited about 250,000 m^3 of sediment in the upper Waiho Valley (Turnbill, 1998). The long term average total sediment transport from the headwaters is about 2 million m^3 per year, the deposition of sediment on the head of the upper Waiho fan between 1993 and 1999 was about 3 million m^3 (0.5 million m^3 per year or 20,000 Truck and Trailers). It is believed that the stopbanks have constricted the sediment transport equilibrium of the river from its usual fan head re-routing behaviour (and consequent fan head incision, as is observed by neighbouring West Coast Rivers) and has raised the head of its alluvial fan to unprecedented elevations (Davies, 2002). The channel is unable to flip across its fan and due to the aggradation optimised geography the Waiho represents a major source of gravel albeit technically uncertified.

6.2.3 South Westland Area

Greywacke and granite are the main types of rock on the west side of the Alpine Fault while only schist is found on the east. With the area rising at a rate of 10 mm / year and the fault within 10km of the coast at the southern end of Westland the copious river gravel outwash has a high proportion of schist. Schist rock is not suitable for concrete aggregate. The ranges to the south west of Jackson Bay consist of greywacke.

Table 6.3: Aggradation Status of some South Westland Rivers (Davies, 2004)

Rivers	Status
Taramakau River (Hokitika/Greymouth)	OK
Waitangitaona River	Changed course 1979
Arahura	OK
Poerua	Landslide onto deer farm – may sort itself out

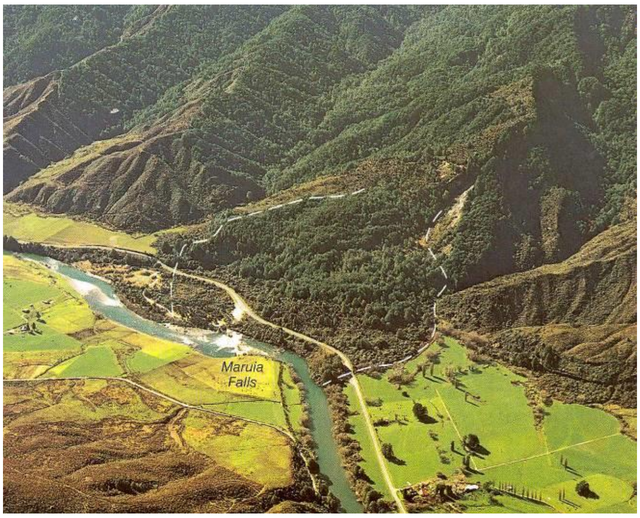

Figure 6.7: Maruia Falls Landslide Adding to River Sediment Transfer System

6.2.4 Other West Coast Aggregate Sources

With its high rock production (10mm per year of seismic uplift) the region exhausts vast quantities of material into the sea. This is either induces coastal aggradation or is transported north and eventually adds to Farewell Spit (see section 10.1.2) via littoral drift. Figure 6.8 shows the aggrading affect the deposits have on the beaches of south Westland and represents an easily accessible bountiful gravel resource.

Figure 6.8: Aggrading Westland beach line

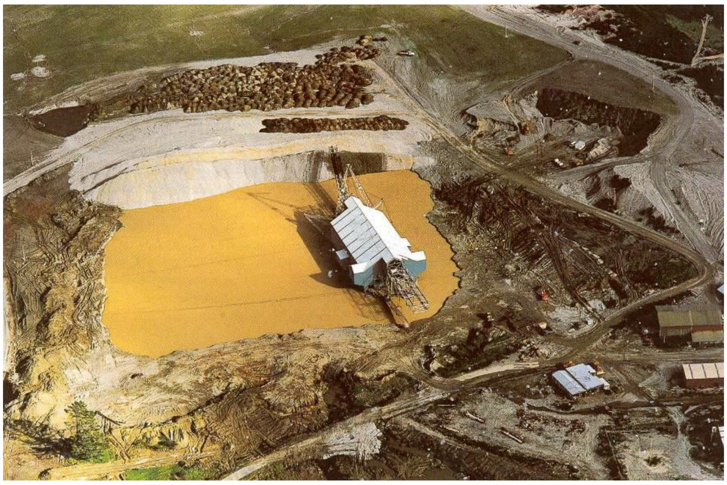

Figure 6.9: Westland Alluvial Gold Dredge and tailings behind

Aggregate from mine stripping (coal and gold) and waste rock from open pit gold operations, along with gold dredges (figure 6.9) are further sources of easily won aggregate within the West Coast region and may be cheaper and easier to win.

6.3 Aggregate Alternatives

Although there has been extensive international research into recycling waste products for road and construction use since the 1970s very little work has been done on exploring the potential use of materials in New Zealand. The resource is subject to reverse sensitivities for as the value of recycled rubbish is realised, its costs tend to increase (Whitehorn, 1999).

6.3.1 Seabed Extraction

Extraction of marine sands is now well established in the Kaipara Harbour and on the east coast of Northland and it is expected that in time, aggregates within the Auckland area will be derived from marine deposits (CAE, 2003). Demand for construction materials from shallow sea bed sources is expected to expand as quarrying becomes more difficult in Auckland. Well base marine dredging operations have clear environmental advantages over land base quarrying operations, and are globally an increasingly attractive way of maintaining the supply of premium grade aggregates at affordable cost. The situation evolving in Auckland is similar to that which already exists in the southeast of England, where 30% of all aggregates produced is now mined from the sea bed. Such a development would have the additional economic benefit of reducing both the capital and maintenance of publicly owned motorways and arterial roads. If the same proportion of Auckland's aggregate needs were to be dredged offshore and unloaded at central distribution depots it would save, or drastically reduce the distance of between 160,000 and 200,000 truck movements per year in Auckland's congested motorway system (CAE, 2003).

6.3.2 Slag

Approximately 270,000T of melter slag are produced annually by NZ Steel at Glenbrook Steel-Mill, Waiuku via the process described in Appendix 2. Steelserv Ltd., a contractor for NZ Steel, who are responsible for the management of the slag have a stockpile of unprocessed slag in excess of 450,000 t. The stockpile is growing annually at over 100,000 TPA and if significant end uses (like basecourse) cannot be developed they will run out of space (Byres, 2003). There is a reluctance to use slag in New Zealand as it is an unknown and therefore presents an intangible risk. But with experience this is expected to change. Owing to slags unique properties, pavements layers can be thinner to attain the same strength as natural aggregates; slag has a longer design life and compacts faster. Once transit has approved the use of slag as a basecourse material it is anticipated that slag will enter the TNZ40 market at $12 - $16 depending on whether it is supplied to the South or Central Auckland areas respectively (Byers, 2003).

Globally slags can differ significantly in chemical composition and suitability as a basecourse depending on their production process. In this regard the melter slag produced here in New Zealand is unique and this should be considered when reviewing foreign literature on slag utilisation. 11 OECD countries use slag as a basecourse material, either combined with natural aggregates, as a mix with other slag types or neat. Significant use of slag is found on the roads in and around the steelworks at Port Kembla and Newcastle in New South Wales, Australia. New Zealand Melter Slag has been shown to be zeolitic in nature, with the ability to filter water on a molecular level. It has been used on the filter beds of town sewerage treatment plants and is being trialed by NIWA for processing dairy shed effluent (Christie, 2001).

6.3.3 Recycled Concrete

In Auckland, there are about a dozen companies that crush concrete for use as roading and concrete aggregate, the largest being Ward Demolition and Adams Landscaping (Adams 1999 production: 50,000 t) (Christie, 2001). Uncontaminated (un-reinforced) concrete is crushed, graded and used as builders mix for concrete construction and stabilised and used as roading sub-base. Recycled concrete aggregates are used in most base course applications where specification is met. The NZ Recycled Aggregate Guidelines Publication lists specifications and appropriate applications, with a quality assurance plan comparable to quarried aggregates. In addition drainage and landscape products are produced. Variations with landscape products include crushed brick and tile. Builders mix is produced for low strength concrete applications. BRANZ (Building Research Association of New Zealand) has carried out research into the application of recycled aggregates in concrete and several councils endorse the use for footpaths and edging. Milled asphalt is combined with virgin materials and reused in Auckland, delivering a quality asphalt at a significantly lower price.

6.3.4 Other Recycled Materials

Scrap Tyres

1.2 million scrap tyres are produced in the greater Auckland area per year (Whitehorn, 1999). Uses include light weight fill, drainage material or combined with asphalt to make Crumbed Rubber Additive Asphalt (CRA). CRA greatly enhances the performance of the asphalt as well reducing the price. Overseas, CRA is used in concrete to give increased durability in free-thaw condition, has de-icing properties and is highly skid resistant. Tyres are otherwise retreaded, land filled or burnt.

WODB (Waste oil distillation bottoms)

2 – 3,000 tonnes is produced annually through refining waste oil. Its use in asphalt production would reduce the cost of conventional bitumen by 40% (Whitehorn, 1999).

Glass

Crushed glass is used at filter material, has been used as asphalt aggregate and an application of 30/70 glass/limestone produces an effective sub-base compacting to standard specifications.

Fly Ash

Fly Ash is produced from burning coal and is widely used in non-structural concrete for its hydraulic binder properties. It could be added to concrete more generally to reduce cement content – although initial strength is reduced the final strength is often greater than without. It is useful for stabilisation of soil sub-grades and road bases or as a filler in asphalt paving mixes. Sources include Huntly Power Station who are currently increasing their use of coal in the face of Maui’s gas supply tapering off. Use is limited by possible impurities that could remain and possibly leach.

Plastics

Virgin plastic is used as an additive to Asphaltic Concrete (AC). New processes allow recycled low-density polyethylene resin to be made into pellets and added to AC at a rate of around 6%. Replacing 20-30% fine aggregate with High Density Polyethylene (HDPE) reduces compressive strength, flexural strength remains unchanged and flexural toughness is increased.

7.0 Transport

7.1 Transport Modes

7.1.1 Barging

When consideration barging aggregate from the West Coast to the Manukau Harbour it is important to consider that Greymouth, Westport and Manukau are some of the worst harbours in the world (Stapleton, 2004); to succeed on the Coast, craft need to be small, fast and versatile. Both Greymouth and Onehunga are bar ports and can be closed due to poor bar conditions; leaving the tug and barge either inside or out for extended periods of time. Greymouth to Onehunga is by far the closest route to the Auckland market. To come around and land in the Ports of Auckland on the East Coast is 741 nautical miles and would take 4.5 days each way. This has the added disadvantage of needing to truck to a stockpile probably further away than an "Onehunga" stockpile (Coombridge, 2004), (Stapleton, 2004). Barges in New Zealand are unloaded using excavators although conveyor technology exists and is used overseas (See Section 7.2.1).

Figure 7.1: Ocean Bulk 1

Greymouth to Onehunga is 381 nm; at an average of 7 knots it is 2.3 days each way; loading takes 12 hours but you need to allow 24 as Greymouth is generally a daylight port and at discharge 24 hours need to be allowed for as well; if the weather is good and the tides are right at both Onehunga and Greymouth bars then a round trip can be achieved in 7 days; however, it is more likely than not that it will take between 7 to 9 days (Coombridge, 2004), (Ganley, 2004). The price for aggregate from the Port of Greymouth wharf to on board a truck at Onehunga wharf would in the vicinity of $38/tonne. This price includes loading, Port of Greymouth and cargo charges, barging, Onehunga port and cargo charges, and discharge into continuous trucks (Coombridge, 2004).

Existing port terminals of the Ports of Auckland are currently used to unload aggregate; they also have readily available information about harbour channels and monitor them for changes. Unloading in the Kaipara Harbour could provide ease of access to northern markets. Channel information could be found from existing sand-dredge and barge operations run by Winstone and Atlas. There is the possibility of loading 10,000T barges then transhipping in Shakespeare Bay Picton or a "floating port" destined for Australia.

Table 7.1: Characteristics of New Zealand Barges

Barge	**Max. Draft**	**DWT**	**T&T Loads**
Sea-Tow 4	4.8m	7,900 t	275
Sea-Tow 8	2.5m	1,000 t	34
Sea-Tow 11	3.6m	1,000 t	34
Sea-Tow 17	3.4m	3,544 t	104
**Union Bulk 1*	*5.0m +*	*16,000 t*	*decommissioned*
**Ocean Bulk 1*		*12,500 t*	

Current New Zealand barges are capable of carrying 1,000, 4,000 and 8,000 tonne consignments (figure 7.1). They travel approximately 60 knots (100 km) per day, take 12 hours to load, 24 hours to unload and require approximately 4m draft (Table 7.1). At present Sea-tow have no barges available, however there is a 6,000T barge arriving in the New Year. This barge will be used on coal shipping to free up Sea-tow 17 for more coastal cargoes including aggregate.

In 1997 Solid Energy began exporting coal aboard the Ocean Bulk 1 (figure 7.1) from Westport to Port Kembla, approximately 65 km south of Sydney, Australia. The Ocean Bulk 1 barge is the largest barge operating in New Zealand and can take up to 12,500T of coal, (38% more than Sea-Tow 4). Unlike Sea Tow 4, the Ocean Bulk 1 is compartmentalised and its cargo can be covered with hatches. Additionally it has its own ship unloading system. Initially coal was trucked to the wharf site until a long term rail receival facility was commissioned. About 14 loads are exported each year, totalling approximately 200,000T of coal. The round trip takes 18 to 20 days. (NZ Mining, v 22, 1997)

Figure 7.2: Map of Greymouth to Onehunga Barge route (solid line) and alternative route from Jackson Bay (dashed)

7.1.2 Rail

Raul haulage is often used for intermediate distances of 50 – 100km, when producers have access to rail connections and stockpiles can be maintained close to consumers. Existing Toll Rail rolling stock carry 50 tonne of aggregate and train combinations can take between 600 and 1,500 tonnes. Loop rail or branch-lines may need to be put in to connect quarries and distribution sites with the trunk network. The undesirable side effects from rail are generally lower than those from road Table 7.2). This is balanced against the lack of door-to door flexibility of rail compared to road transport.

The New Zealand rail sector is currently undergoing significant change. Toll Holdings Limited (“Toll”), an Australian transport and logistics operator, have acquired Tranz Rail. Further, the Crown has brought back the track and associated infrastructure. The Crown has re-established NZ Rail Corporation as a State Entity that owns and operates the network. The 2003 Toll – Crown Heads of Agreement specified that the Crown through NZR would invest \$200M over five years in track infrastructure and Toll would invest \$100M in rolling stock.

Table 7.2: Pros and Cons of Rail Use

Advantages	Restrictions
Quick to load	Track quality
5 mins/wagon to unload (through base)	Speed restrictions through towns
Travel at 100 km/h	Cook Straight Ferry
24 hours a day	Co-ordination with other trains on track

Despite increasing the quantity of freight carried in the mid-1990s, the rail business has not been able to recover its cost of capital for many years. Parts of the rail network, usually tunnels, are not capable of taking the longer or higher containers that are increasingly used internationally. The proposed Government investment in the railway network is expected to reduce the level of deferred maintenance. However, under the new regime there are some policy issues surrounding rail and land transport generally which are at present unclear. This includes funding issues (e.g. the framework for funding alternative to road projects) and pricing issues in relation to roads (which impact on competitiveness between road and rail) and access pricing for the rail network. The Alternative to Roading framework for funding rail investment focuses on benefits to road users, rather than wider national benefits.

The New Zealand rail network has a route length of 3807km. There are some lines that are marginally viable from a commercial perspective but which might have wider economic and regional benefits (e.g. Napier – Gisborne Line). The rail infrastructure condition, while generally meeting a "fit for purpose" test for current freight operations, is the victim of low levels of asset replacement with consequential implications on the quality and reliability of services and requires significant investment to cater for the changing and growing freight and passenger demands. At the same time the rail link provides opportunities for future development of industries which would use rail transport and provides an opportunity for rail to become the prime mover of bulk cargo.

7.1.2.1 West Coast and Midland Line

Coal volumes on the Midland Line have increased from 0.2 MTPA in 1976 to 2.1 MTPA in 2003 (Figure 7.3). Solid Energy's 15 year plan will see these volumes grow to 4 MTPA by 2009. The strategy is to mine to the capacity of the transport infrastructure. Tranz Rail own the wagons, with cost of the wagons amortised into the rate charged to Solid Energy through a long term contract. Currently Toll is running 6 train sets of 24 wagons per day. 75% utilisation/performance of the infrastructure was achieved in 2000, 85% in 2002. The target for 2003 was 90%. Solid Energy considers that utilisation can get to 95% by dealing with infrastructure reliability, temporary speed restrictions etc. before being constrained by weather and maintenance windows. Investment is required in rolling stock. Deferred maintenance needs to be addressed to enable an increase in utilisation to 8-9 train sets of 30 wagons per day. This will assist in lowering Solid Energy's transport costs, where over half the price of the commodity at the Port of Lyttleton is transport cost. Solid Energy have improved load out facilities (aerial ropeway), Lyttleton Port has reduced unload time from 2 hours to 1 hour (should also be achievable for 30 wagon trains). Oceana Gold intends to rail 95,000 tonnes of West Coast gold ore to its Central Otago Macraes mine for final processing (see section 5.2.3.1). For Pike River Coal Company (see section 5.1.2.3) use of the rail option requires access to the line at competitive commercial terms.

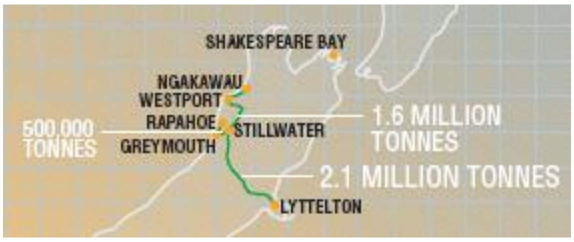

Figure 7.3: Midland Line Transported Coal Volumes 2003

Key issues with the South Island coal route are:

- Deferred maintenance is estimated at $50 million. The work, mainly to structures and track and to increase axle loads, is required to support existing volumes.
- Electrification back to Jackson would double the capacity of the Otira Tunnel.
- There are serious concerns regarding timber bridges being loaded at or above rated capacity and regarding the risk of track buckling.
- A number of grades need to be eased to allow an increase in train tonnages
- The Cobden Bridge is at the end of its useful life and needs to be replaced (Solid Energy estimates the cost to be $10 million).

7.1.2.2 Auckland Rail

The Auckland Regional Land Transport Strategy (RLTS) outlines aims to generate 25 million rail passengers /year by 2015. It states that to achieve these aims, one of the requirements is a major upgrade of the existing Auckland Rail Network to increase capacity. This upgrade is to include improvements to the network. The investments required in infrastructure to achieve these aims are described in table 7.3 below. They involve upgrading the core network to achieve a level of capacity and quality consistent with a modern rail system. Key initiatives include electrifying and double Rail tracking the Western Line, electrifying the NIMT and Isthmus lines, construction of the Manukau Link and an upgrade of signalling on all lines.

Table 7.3: Proposed Auckland Passenger Rail Projects

Project	Capital Expenditure ($M)
Initial package – Priority 1 Projects	
Western Line Duplication	$59.40
Network Track work	$8.70
Western Line & Newmarket Signalling Upgrade	$14.00
Sub-total	**$82.10**
Package 2	
Signalling Upgrade: South, East & Isthmus Lines	$33.50
General Civil Works: South, East & Isthmus Lines	$9.50
Otahuhu – Westfield Track works	$7.60
Train Storage & Light Maintenance	$5.50
Manukau Link	$40.60
Priority 3	
Electrification	$102.90
Priority 5	
Supplementary Signalling	$32.80
Sub-total Priority 2-5 Projects	**$232.40**
Total	**$314.50**

7.1.3 Trucking

Transportation costs are generally 35% of the total cost of aggregates, which limits truck haul to less than 65 – 80 km to be competitive (Byers, 2003). In Auckland truck haulage is almost the only form of transport used for aggregate distribution. Truck and trailers with payloads of 28 and 30 tonne are the norm. In the United States, 90% of aggregate is transported by truck, with an average truck haul distance of 50km. Rail becomes economic over 60 km. In the U.K. 15% of aggregate is carted by rail and sea-borne aggregate is barged to cities produced by coastal quarries. In general, road transport is the most flexible option and there are no inter-modal costs, as rail and barge options still require some form of truck haulage (Christie, 2001) Truck haulage is the most common mode of transporting aggregate and is the preferred choice for distances up to 50km.

Congestion affects the Auckland region most highly. Use of the roads gives rise to a number of environmental and other impacts including noise, emissions, contaminated water run-off, accidents, and congestion. A Transit NZ study is currently underway to estimate the costs associated with these impacts and the extent to which they are factored into existing charges for using the road network.

Studies evaluating the impact of *Pike River Coal Company* (PRCC) trucking coal approximately 40 km from the dewatering complex to Port of Greymouth are in progress. Alternatives to conventional 40 tonne trucks carrying 28 tonnes of coal are being evaluated. Such alternatives include 110 tonne truck and trailer units carrying 80 tonnes of coal, or trucking to a rail point for transfer using the existing line to Greymouth. The larger trucking option requires an exemption from New Zealand road transport regulations. Strong grounds for an exemption exist as it would allow the number of truck movements to be reduced by two thirds with significant safety benefits and would facilitate a major new export.

The Grey District Council have proposed that 60 km of road between the Port of Greymouth and the Pike River Coal Company be upgraded to State Highway status; the most suitable route is at yet undecided. The PRCC will be transporting 1 MTPA of coal and the projected transport of bulk volume products may exceed current arterial route capacity within Greymouth. The initial resource consent is for approximately 74 laden trucks a day, 350 days per year (0.65MTPA). This will later increase to the equivalent of 125 trucks per day (1.1MTPA).

Table 7.4: Predicted Port of Greymouth tonnages over the next 10 years

Coal	2.3 Mt
Timber	44,000T
Aggregate	30,000T
Gold Ore	65,000T
Fish	20,000T

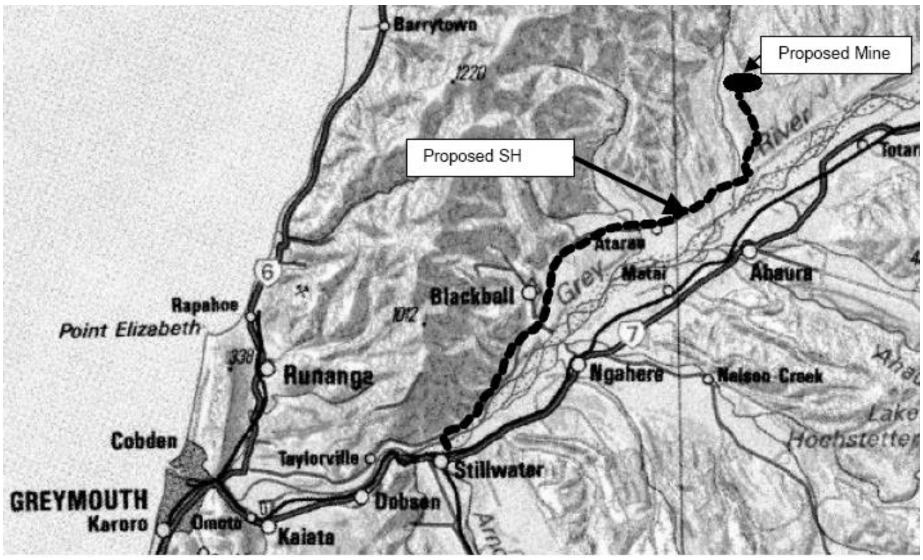

Figure 7.4: Site of proposed PRCC mine and route to be upgraded

The PRCC and Greymouth may be considered to be locations of national economic significance such as Marsden Pt, Cape Foulwind, and Glenbrook Steel Mill. A bridge across the Grey adjacent the site would increase conflict between light vehicle and heavy vehicle traffic. The level of funding required to pay for the road improvements is beyond the Council's ability to raise. The Council is investigating other funding options, including differential rates, direct contribution from the coalmine company and regional development funding. Once consents are approved lead time to production is relatively short compared to the lead times needed by the Council to secure funding from Transfund. The West Coast Regional Council has a $100,000 budget from Transfund to undertake an Alternatives to Roading Study to assess the possibility of building a rail link from the mine to the port. There are long term safety concerns regarding the current route to the port.

7.2 Port Development

7.2.1 Inter-modal Efficiencies

7.2.1.1 Systems

The Sea-Tow / Solid Energy coal barges that currently use the Port of Onehunga are required to remove cargo off site as it is unloaded. Unloading of the 8,000 tonne coal cargo typically takes 17 hours. This is achieved using two Ex 220 and Ex 400H diggers in figure 7.6 (Operated by Smith & Davies) bucketing into truck and trailer units that cart to off site stockpiles. The excavators mount the barges with the assistance of the log in figure 7.5.

Figure 7.5: Log used at Onehunga to act as a ramp for excavators while mounting barge to begin unloading

Figure 7.6: Excavators at Onehunga currently used to unload barges

At both termini of the Greymouth to Onehunga vision much scope is afforded for integration of port and rail operations. To cope with the higher standards of pollution control and the increasing demands on inland bulk transporting bulk handling systems at loading and unloading installations should utilise the most up-to-date technological systems available. The optimised integration of water, rail and road transportation systems is the key to the efficiency of a logistics hub. Multimodality bundles cargo flows and builds competitive transportation chains with optimised upstream and downstream operations. A number of ports use inland ports or cargo hubs to ameliorate storage constraints, minimising the time that any cargo absorbs storage capacity on the port itself. This approach relies on good transport links. Ports Transport links are the third likely constraint on a number of ports. This affects Auckland in particular, but a number of other ports as well, where cargo has to move through residential areas and in situations where particular links do not exist (e.g. the lack of a rail link to Marsden Point).

In figures 7.7 through 7.12, are examples of internationally readily available transport solutions. As aggregate shipping volumes increase these systems become progressively economically attractive. Self-unloaders (figure 7.6) allow increased operational flexibility and simplifications in port layout.

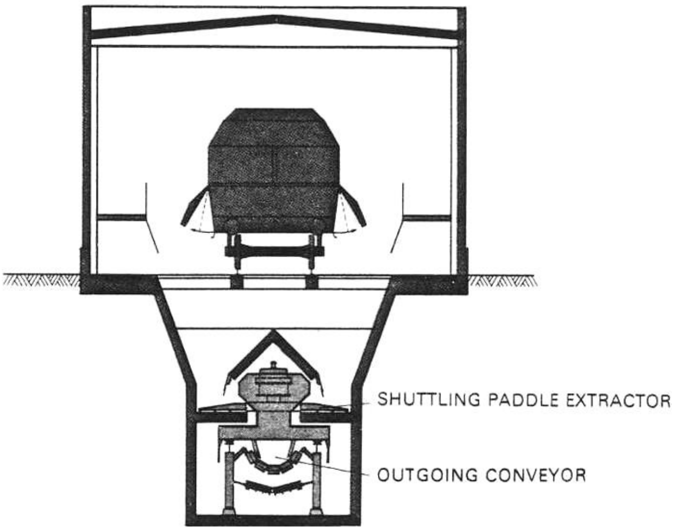

Figure 7.7: Reception bunker and bottom-discharging wagons, with a moving paddle wheel extractor at the bottom

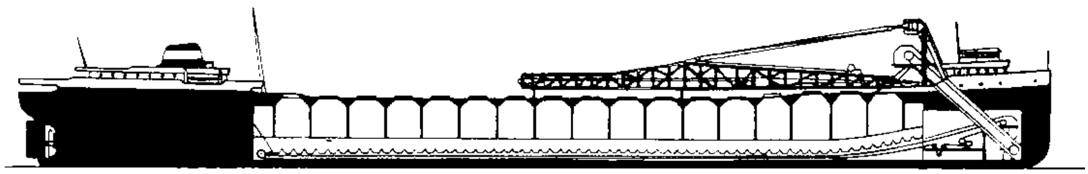

Figure 7.8: Pan and Boom Conveyor and Deck System

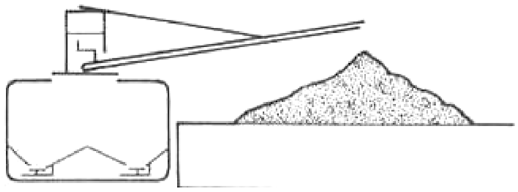

Figure 7.9: Discharging directly to stockpile

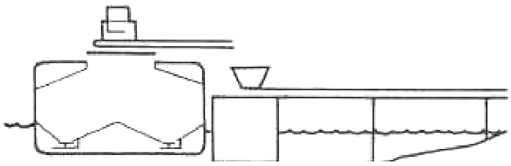

Figure 7.10: Discharging to shore based conveyor belts

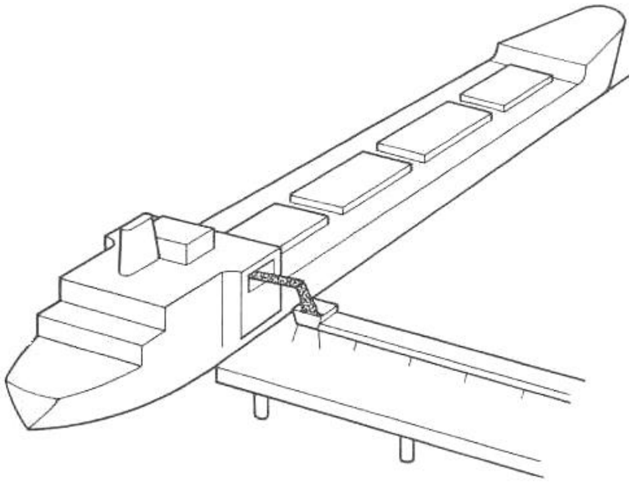

Figure 7.11: At multipurpose terminals

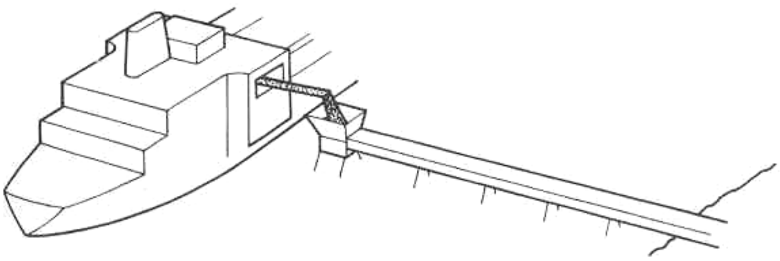

Figure 7.12: Simple pier-layout

7.2.1.2 Constraints on Port Development

At the Port of Onehunga there are no current plans for expansion. The site is marooned on its peninsular by the South Western Motorway. Adjoining land shares borders with the motorway and the harbour. At Greymouth there is an area of adjacent land earmarked for port development.

Access to the Port of Greymouth is through the tight streets of the township of 10,000 people. Rail is 1 km remote from the port. There are plans to remedy these two constraints as other West Coast Industries step up tonnages through the port. The Port of Onehunga is well sited being near the industrial suburbs immediately south of the city’s CBD. Road access is superb and the disused existing Onehunga-Penrose branch railway laid right to the wharf could, on face value, be resurrected without much expense.

If it was feasible, it would be beneficial to reclaim additional land at Onehunga. This is a lengthy and expensive process, limiting its commercial feasibility to circumstances where the port’s trade is sufficient to support such an expensive project. Any land reclamation is subject to the Resource Management Act and expansion cannot be guaranteed to be permitted.

7.2.1.3 Integration with land transport

Railroad, truck and barge each have distinctly advantageous characteristics peculiar to themselves and in the past each has proved its worth in its own sphere of action. On face value it is often surmised that having all three modes in the same locality would, by conflict of interest, reduce the efficiency of one or all of the systems. However there is ample evidence, particularly in Europe that by wise administration, the services can be complimentary. In Germany (where railways and waterways are owned by the state), there by judicious and intelligent administration, both highway and waterway services have attained remarkable prosperity and their harmonious co-operation has allowed them to become powerful factors in the economic advancement of the community. (Ferriday, 1922)

As a general rule, rail is more heavily used in export trade (delivering to ports) than import trade (delivering from ports). This pattern generally arises as exports are more likely to be hubbed from a specific location (a plant producing the goods), whereas imports are more likely to be delivered to a wide range of ultimate destinations. Ports of Auckland noted that the vast majority of import containers were delivered within 30km of the port.

The key to successful remote aggregate industry would appear to be optimisation of new opportunities for the delivery of the product to the market. Remote sourced barged aggregates present a range of transport alternatives not available to, or not utilised by, the traditional aggregate producers. As the cost of transport is a major part of the delivered price of aggregates in the Auckland region, optimisation of the delivery system could achieve considerable competitive advantages.

The location of the onshore terminal requires careful and extensive analysis, due to:

- The range of locations available
- The opportunities presented by different locations
- Constraints attached to each location
- Transport economics of each location

7.2.1.4 Synergies

- Port of Greymouth or Manukau Harbour dredgings and barged material could be used to construct a Manukau landing terminal. Excess material from the dredged channel could also be used.

- The first temporary berth could be made available through the development of a dredged channel and land reclamation which could accommodate the on shore facilities.
- Any excess sand could be sold as fine aggregate. Rail and road access from Onehunga could facilitate ease of access to a satisfactory distribution network.
- The development of the Auckland Airport second runway is as yet not fully planned. A combined airport – port development may present significant opportunity for a barged aggregate project as associated dredging works to supply large quantities of fill.

7.2.2 Planned Future Developments at Port of Greymouth

The Grey District Council as port owner has approved a staged approach to port development. This has started with creating the ability to handle 500,000 to 600,000 tonnes of coal per year and reviewing progress annually, subject to viable medium term agreements being reached with customers concerned. Coupled with this is a conscious commitment by the Council to develop the port further as and when future potential trade is committed by customers. The Council has appointed a Port Action Committee to promote development planning.

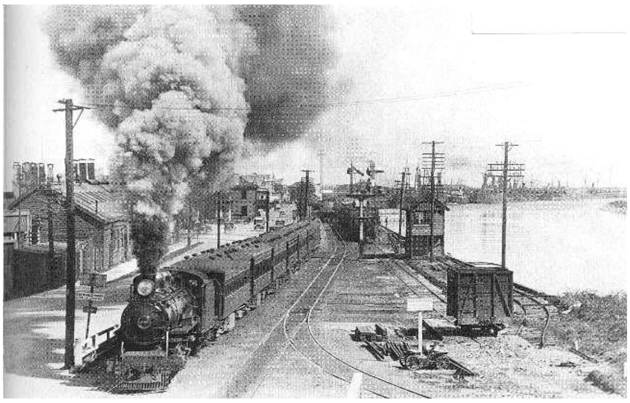

Figure 7.13: Rail access to Port of Greymouth in its heyday

This move has been prompted by pending increases in coal production in the Grey District from about 450,000 TPA to 900,000 TPA as Solid Energy's Spring Creek Mine comes into full production in 2004 and to over 2 MTPA with the expansion of the Roa Mine and the proposed Pike River mine coming into production. Potential markets are international export via coastal or Trans-Tasman shipping to a transhipment port capable of Panamax or larger ships, or North island industry facing a loss of natural gas supply.

The decision follows from Phase 1 of a Port Development Options Study by Opus International Consultants Ltd. The study focused on the potential coal trade, with regard to the needs of aggregate, ore, timber, general cargo and fishing. Phase 1 analysed engineering/infrastructure requirements of a port most suited to different levels of coal trade. Annual shipments of 500,000 tonnes, 1.1 MTPA and 1.7 MTPA were considered.

The Opus report concluded that, while Greymouth is a river port with a difficult entrance across a bar, the Port can be managed and developed to provide a viable coal exporting system via a trans-shipment port, which is competitive in cost to railing to Lyttleton.
Further key conclusions:

1. The risk of unpredictable entrance conditions can be well managed by integrating ship size and berth and stockpile provision with the mine production rate and the required delivery rate.
2. The existing Richmond Quay river wharf is outdated, but it is appropriate that as much use as possible is made of the present wharf while ongoing proof loading shows that this can be done safely, particularly as coal trade continues with a small throughput that could not support major infrastructure investment. However, the existing wharf is not suitable for a large throughput and planning for higher tonnages should allow for full replacement. The timing of the need for the new berth cannot be pre-determined as it depends on the ability and cost to keep the existing wharf in safe condition versus replacement cost, and the level of trade available to fund replacement.
3. A new shipping basin on the Cobden side of the river could be developed and provided with road and rail access, but would cost significantly more than developing at the existing Richmond Quay site, and the access road and possibly the port storage area (depending on location) would raise flood levels in the river upstream. Advantages include berths out of the river flow and reduced exposure to surge, avoidance of land transport routes through central Greymouth, and avoidance of the need for Cobden Rail Bridge for Rapahoe coal, but the site would be closer to residential Cobden and require a Cobden bridge for rail access from the Pike River coal mine.
4. Developing a new cargo berth in Erua Moana Lagoon would provide a berth outside the river flow adjacent to existing cargo facilities, but would require ongoing maintenance dredging or special structures to maintain water depth and would be disruptive of the fishing industry.
5. An angled berth inset into Richmond Quay could provide a cargo berth largely protected from the river, could allow the turning of longer vessels, and would require minimal maintenance dredging.
6. Ships of up to 109 metres length overall can be turned at the existing Richmond Quay berth. If longer ships are required, as suggested for the 1.7 MTPA option, these could

be accommodated at this site by either removing part of the opposite river training wall, or providing a turning knuckle at the Erua Moana Lagoon entrance.

7. Enlarged coal stockpiling on land near Richmond Quay can be provided for with unloading systems for rail and road.
8. Alternative road access avoiding the Greymouth central business district, or reinstating rail access to the existing port site, can be provided for and should be considered for the higher tonnage levels.
9. Covering coal stockpiles becomes economic at higher tonnage levels by reducing the water content of coal (saving transport costs and raising the heat content) and reducing the potential of dust generation.
10. Allowance can be made for the timber, aggregate and ore trades at the berth provided by coal, without greatly interfering with the coal trade. However if other trades increased significantly, the need for a second berth would be brought forward.
11. The fishing harbour can be maintained in Erua Moana Lagoon, with further provision for unloading berths, if growth continues. However, the Martin Quay unloading wharf is also outdated, but can be retained in the short to medium term with continued proof-loading and upgrading. In the medium to long term new berthage will be required, as demand warrants and finance becomes available.
12. The sequence of port development needs to be matched to customer requirements but, because the sequence of potential trade increases is not clear, it is not yet possible to determine the development sequence.
13. Coal will be the major catalyst. It may be that one of the potential coal trades develops, or all of the potential may develop in a very short time sequence. It is also not clear whether major coal developments will commit to a road or rail system for access to the port.

A key output of the Phase I report is a series of models that can be used to test varying assumptions for port operating conditions, cargo volumes, market destinations, international and coastal shipping type and size, transhipment ports, stockpile sizes, berth numbers and locations, coal handling infrastructure, road and rail access improvements, and assumptions on project life, equity / debt ratios, rate of return on capital, debt repayment and interest rates, inflation rates and tax rates. A phase II report will follow to develop details from coal handling once customer and community requirements are clarified.

Once the Pike River mine is developed it is proposed to upgrade the current coal loading facilities to incorporate stockpiling and loading facilities and to utilise 12,000T capacity barges which should substantially reduce barging costs. If the Erua Moana was developed and dredged it would significantly add to tidal storage, which would help to scour the bar and keep the channel open. Disposal of the dredgings could be used as marketable aggregates.

7.2.3 Granity Coal Export Jetty

The proposed West Coast Coal Terminal and export jetty located near Granity a small community of 300 approximately 32 km north of Westport, would provide a long term asset for the coal mining industry on the West Coast. The jetty would enable Solid Energy to access large overseas markets at internationally competitive prices. The new facility would reduce the cost of West Coast coal from the highest quartile for cost on a delivered basis to the lowest quartile. Railing coal 397 km to the Port of Lyttleton meant transport costs exceeded mining costs; the jetty would reduce transport costs for Buller coal from approximately US$41/t to US$25/t. The Granity jetty would also enable Solid Energy to double its current coal export volume.

Figure 7.14: Granity – proposed site of Coal Terminal

The proposed export facility consists of:

- an on-shore site of some 30 ha
- dual-row coal stockpiles with overhead stacking
- an underground reclaim
- a water supply pond
- primary and secondary stormwater treatment ponds
- A jetty of 2,200 metres length
- A wharf capable of loading vessels of up to 100,000 tonnes.

The proposed Granity jetty - the longest of its kind in New Zealand – would be open to shipping approximately 70% of the time. The prime design constraint is the high seas possible in this stretch of water. If significant waves (as classified by duration, frequency and size) reach 2 m in height the jetty would be closed. Testing has shown that for 71% of the time significant wave heights were below 2 m for periods of more than 24 hours, the time required to load a ship. Institute of Geological and Nuclear Sciences study found the potential for liquefaction beneath the piles was found to be minimal.

The proposed jetty facility will allow the export of coal directly from the West Coast to growing markets in Asia and South America. Coal would be brought by train from Rapahoe to the $170 million facility. The biggest concern during the consent stage of the proposal was the trucking of coal from the Grey District to the proposed jetty site at Granity. With 57 ship movements per year and the shipment of some 3 MTPA coal, the jetty could also be used for products such as ilmenite and aggregate.

The onshore facility would be capable of receiving coal from aerial ropeway, rail, road and barge. From the wharf 4,000 t/hr of coal would be loaded by a covered conveyor belt into purpose-built vessels, ranging from 20,000-100,000 DWT.

7.2.4 West Coast Deep Water Port

The desire to build a deep water all weather port on the West Coast has over a century of history as detailed in Appendix 1. With the current mining renaissance on the Coast it is again a topic of consideration. Estimates of cost from Port of Greymouth Harbour Master were of the order of $300M (Stapleton, 2004). The Port of Greymouth Website declares “Council will support any new initiatives for a Deep Water Multi-Purpose Harbour and Port at Rapahoe (Point Elizabeth” where such an initiative can be proven to be entirely funded and underwritten by private industry” (GDC, 2004).

7.3 Shipping Industry

7.3.1 Ship Co

Ship Constructors designs and builds steel vessels including ferries, tug boats up to 70 tonnes bollard pull, fishing vessels, barges, landing craft and expedition yachts. The company has built 65 ships since its inception in 1990. The company builds it’s vessels on a 12,000 m^2 shipyard in Whangarei. Ship Constructors have the facilities to launch vessels up to 100 metres in length, 30 metres in beam, weighing up to 2,500 tonnes and with a draft of 4.5 m. Ship Constructors built the 34 m ocean-going tug *Sea-Tow 25* for use in hauling the companies barges in New Zealand coastal waters and for work offshore.

Figure 7.15: Ship Constructors yard in Whangarei

"*The barge 'Sea-Tow 4', a 97 metre deck cargo barge was built, in 20 weeks in 1994, from keel laying to launching. Weighing 1,980 tonnes at launching, this deck hopper barge has a cargo capacity of 8,000 tonnes. The main deck is made from Grade 350 steel and is specially designed for heavy lift work and for this purpose the starboard side aft and the complete aft bulwarks were made removable. The barge was designed by Ship Constructors Ltd to American Bureau of Shipping Standards as a shallow draft vessel to negotiate the bar harbours on New Zealand's treacherous west coast"*

(Ship Constructors, 2004)

Figure 7.16: Sea Tow 4 under construction

7.3.2 Sea-Tow

Sea-Tow is the southwest Pacific's largest tug and barge company with its head quarters in Birkenhead in Auckland Sea-Tow is 50% owned by Northland Port Corporation of Whangarei and 50% owned by Adsteam Marine, a large Australian maritime company. They currently operate four tugs (750hp - 4000hp) and four barges (1000T – 8000T capacity) from New Zealand and have additional vessels available in Australia. Sea-Tow specialises in providing a stockpile to stockpile logistics package coordinating all onshore transport, loading and discharge of the barges and port company matters. The company's barges have large beam-to-length ratios, enabling them to operate at relatively shallow drafts. Comparison of their various barges is provided in table 7.1 and in figure 7.18 capacity of their barge fleet is compared against truck and trailer equivalents.

Figure 7.17: Sea-Tow 4 under tow from Sea-Tow 25

Figure 7.18: Capacity of Sea-Tows barge fleet measured in truck and trailer equivalents

8.0 Economic Feasibility

8.1 Economic Considerations

The success of any mining venture is largely due to a viable extraction method as well as efficient delivery of the product. Aggregate usage broadly follows the state of the economy; it is used in large quantities for building roads and buildings (mainly concrete) and because of the low value per tonne, transport costs are a major factor in the economics of supply.

> *"At the moment it is only economical to bring up specialised aggregates for exposed concrete and decorative purposes, gardens, landscaping etc. this is because there is enough aggregate still in the Auckland market to meet the current demand. This will not be the case in future. The future price will be governed by the next closest or most economical and available supply."* (Coombridge, 2004)

8.2 Start-up Capital

8.2.1 Government Incentives

8.2.1.1 Regional Development Assistance

New Zealand Trade and Enterprise is the New Zealand Government's agency whose commission is to help New Zealand businesses achieve success domestically and abroad. Their *Regional Partnership Programme* is of major assistance to the proposed venture. The programme gives regions guidance and funding to develop and activate sustainable economic growth strategies. Proposals are developed by "communities of interest" working together for sustainable regional economic growth. The key is cooperation between a region's stakeholders and government. Funding available includes: strategic planning: up to $100 000 per region, capability building: up to $100,000 per year, inter-regional capability building: up to $100,000 per year, and for Major Regional Initiatives: up to $2 million.

8.2.1.2 Venture West Coast

Born out of the NZTE Regional Development Program are Venture West Coast (Regional Economic Development Governance Body) and its District Council offshoots:

- Buller Economic Development
- Grey Region Opportunities Workshop (GROW)
- "Westland's Working" Committee

Venture West Coast is made up of three district councils, two Iwi tribes, one Regional Council and West Coast Development Trust

8.2.1.3 West Coast Development Trust

The Trust was established in April 2001. An initial capital settlement of $92 million was provided by the New Zealand government as part of an 'adjustment package' that was received for the loss of the indigenous forestry industry and privatisation of much infrastructure in the late 1990's. The Trust provides and facilitates business investment, business support, employment opportunities, educational and skills initiatives and training services in the region. The main working areas of the Trust are:

- Financial market investment of the capital, which provides revenue to enable loans to be granted to West Coast businesses
- Direct Investment
- Economic development (such as development funding; providing loans and equity into new and developing West Coast businesses) and Community development

8.3 Operating Revenue

8.3.1 Price of Aggregate

Aggregate is a high volume, low value product which is expensive to transport. Aggregate markets are highly competitive. Pricing is an important competitive factor, with operating margins relatively static or reducing over recent years due to the intense competitive nature of the markets. A wide range of projects are tendered and predominantly won on price.

There are 3 product levels within the aggregate market, which equate to the level of processing and consequentially cost. They are ranked in decreasing price as follows:

1. Road sealing chip
2. Concrete aggregate
3. Roading Base course

The price of aggregate is driven by availability and cost of the resource itself. Around Christchurch there is an abundance of alluvial sources where as in Auckland it is quarried.

Table 8.1: Generalised Relative Prices per Cubic Meter at the Quarry Gate in 2001 (adopted from Christie, 2001)

Product	Auckland Area	Christchurch Area
TNZ Sealing Chip	$37.00	$21.00
Concrete Aggregate	$24.00	$10.00
Basecourse	$16.00	$6.50

Table 8.2: North Island Aggregate Prices per Cubic Meter (RMS, 2002)

Product	Area	Price
TNZ Sealing Chip	New Plymouth	$73.00
	Auck - Lunn Ave	$34.00
Concrete Aggregate	Auck - Brookby	$26.00
Basecourse	Auck - Lunn Ave	$28.00
Sub-base	Auck - Lunn Ave	$27.00

Table 8.3: Approximate Prices of Roading Aggregate in Auckland (Byers, 2003)

Product	South Auckland	Central Auckland	North Shore
Basecourse	$15.00	$19.00	$21.00
Sub Base	$9.00	$12.00	$15.00

8.3.2 Transfund's Alternatives to Roading (ATR) Funding

See section 9.1.3.

8.4 Start up Expenses

8.4.1 Barge Construction

Steel is the main component of a barge; subsequently the main price driver is the unit price of steel. Steel is currently (Aug. 2004) US $1,300 / tonne with an expected price rise from NZ$900/T to $1400/T by April 2005 on account of the demand for steel to supply the Chinese industrial boom.

To construct a barge similar to Sea-Tow 4 (8,000 DWT), a purpose built West Coast craft, would take 1,000T of steel. If design was done in New Zealand (ideally it would be) and the barge was constructed in China, pricing would be of around NZ$4.5M + design = NZ$5M. Alternatively, if the barge was designed and built within New Zealand, say at Ship Constructors in Whangarei it would cost $9M. A new tug is of the order of NZ$8M. (Hardie, 2004)

8.4.2 Deep Water Port

The local estimate of cost to construct a deep water port at Point Elizabeth is $300M. The 2.3 km long Coal Export Jetty at Granity was expected to cost $170M.

8.5 Operating Expenses

8.5.1 Transport Costs

8.5.1.1 Port of Greymouth

There is a port facilities charge of $3.20/T (covers navigation, resource consent, maintenance). The operation is self loading (T. Croft Ltd are available loading contractors)
Barging Greymouth to Onehunga takes 2 days, costing around $26/T on truck at Onehunga (Ganley, 2004). With recent increases in fuel and other commodities $30/T (Coombridge, 2004) may be a more realistic/up to date figure.

8.5.1.2 Onehunga

To use the port there is a general felicity fee of $105. To land barges a POAL tug is often used along with the barges own tug. Such assistance to push attracts a $500 one off fee. One POAL staff is to be present at all times, there is an $85 water flat fee for use wash down and/or fresh water for the vessel. It is a requirement that there are to be at least two labourers on the wharf, working at lines men to tie up the vessel and to help clean the wharf; hosing it down and leaving it as found. Personnel need to be equipped with appropriate personal protective equipment include high visibility vests. The weigh bridge is operated by Holcim and requires their permission for use, possibly attracting a fee. Should it be needed salvage by tug is provided at $450/hour (Scott, 2004). Trucking to site in Auckland could cost a further $12 and $14/T.

The costs below in table 8.4 were prepared by RMS in 2000 for the Port of Greymouth and are for a single one off load. With cost dependant on the size of the load -- the lower end of the range is for a load size of 7,500 – 8,000 tonnes and the higher end is for load size of 3,500 – 4,000 tonnes. Prices are dependent on the cost of fuel, availability of vessels and the number of loads required.

Table 8.4: Approximate Costs of Barging Aggregate from Greymouth (RMS, 2002)

Destination	**Distance (Nautical Miles)**	**Cost**			
		/nm/T	**/T**	**Port Charges/T**	**Total/T**
Sydney	1075	4c - 6c	$43 - $64	$9 - $10	$52 - $74
Tauranga	725	4.5c - 6.5c	$32 - $47	$8 - $9	$40 - $56
Auckland (East Coast)	707	4.5c - 6.5c	$32 - $46	$8 - $9	$40 - $55
Whangarei	658	4.3c - 6.3c	$28 - $41	$8 - $9	$36 - $50
Onehunga (Auckland West Coast)	**380**	**7.3c**	**$27 - $28**	**$8 - $9**	**$31 - $39**
New Plymouth	251	5.6c - 7.5c	$14 - $19	$8 - $9	$22 - $28
Wanganui	261	7.2c	$21	$8 - $9	$29 - $30
Wellington	287	5.2c -8.0c	$15 - $23	$8 - $9	$23 - $32
Napier	471	4.5c - 6.5c	$21 - $31	$8 - $9	$29 - $40
Gisborne	527	4.5c - 6.7c	$24 - $34	$8 - $9	$32 - $43

IF: it is assumed that:

- The cost of bulk transport by rail to the North Island would be more than 10 cents per kilometre per tonne
- Transporting by sea-going barge would generally involve a shorter travel distance
- The cost by barging would be no more than 8 cents per tonne per nautical mile
- The quantity to be barged would be 10,000 tonnes per year

- Costs do not include transport to the Port of Greymouth
- Costs do not include transport away from destination port
- Port charges would be the same at all destinations:
    - Greymouth charges include port fees, storage fees & loading costs
    - Port of destination charges include port fees, storage fees & unloading costs

THEN: *"It seems that the only potentially cost effective method for bulk rock and aggregate transport from Greymouth is barging"* (Resource Management Services, 2000)

8.6 Corporate Matters

8.6.1 Potential Partners

The possibility of sharing risks and rewards with established industry participants has many benefits to both new comer and experienced player alike. Fresh ideas and contacts are especially lucrative for out-of-the-way West Coast. Local knowledge and expertise likewise, are invaluable for achieving traction in an unfamiliar realm. The following entities have possible synergies with this projects proposed endeavour.

8.6.1.1 West Coast Rock Alliance

The specifications of the district's quarry rock were measured by Grey Region Opportunities Workshop (GROW). Research into the market potential for rock and aggregate was also undertaken and is being followed up. A hard business network has been established within the companies who are in the rock industry. Currently six companies have bought into the network and a memorandum of understanding has been drafted.

8.6.1.2 Ports Action Group

A West Coast group formed to facilitate co-operation between Ports of Greymouth, Westport and Jackson Bay for the benefit of the province.

8.6.1.3 NZ Rail (NZRC) and Toll NZ

Loop tracks would need to be built to Auckland Aggregate distribution centre and most probably from the intended extraction site on the West Coast and again to connect with port facilities (At Greymouth or future Granity Wharf). Railing aggregate to the Rodney District (The highest growth factor in the country) on the North Auckland Line is a further area for co-operation.

8.6.1.4 Transfund NZ, Transit NZ, ARTA and Road Controlling Authorities

Having local and national road and rail controlling authorities (concerned with road maintenance costs and life expectancies) involved in the planning of an aggregate distribution centre will be important for the implementation process.

8.6.1.5 Solid Energy

With an all time record demand for and production of coal but restricted by current transport bottlenecks, Solid Energy faces similar growth hurdles as this projects endeavour. Better rail, road, and port facilities on the Coast and Auckland especially with relation to the ports of Onehunga and Greymouth are mutual goals.

8.6.2 Potential Threats

8.6.2.1 Contract Uncertainties

In New Zealand's current business environment, industry players are prone to walk away from contracts, leaving the other party in varying degrees of liquidity. This is especially prevalent for large well established firms. The ability to borrow to raise capital in the commodity trading economies of East Asia relies on "Letters of Contract". In New Zealand a large company may "walk away" from contracts 6 months into the agreement, in full knowledge that smaller players do not have the wherewithal to launch legal proceedings. "What to do?" (Ganley, 2004).

8.6.2.2 Competition

Construction is a competitive industry that has shifted toward greater emphasis on cost and service. There are many firms in the industry that are equally placed with respect to economies of scale, access to raw materials, or other cost drivers, to win a new player needs to invest in development, quality and service instead. There are a number of competitors in the industry that control costs through vertical integration. Internal aggregate supplies can be used to gain a cost advantage (e.g. Allied Readymix, Holcim)

1. Winstone are supplied through the Port Greymouth by West-rock, marketed by West-stone, the operation is run by a co-operative of local quarryman. The material is currently only decorative material but the co-op has plans to develop the market with Armourstone to start. It is landed at Onehunga, and transported using *Sea-Tow*
2. Southland Sand and Gravel Co. – Export decorative, exposed aggregates out of the Port of Bluff. Shipping usually consists of a back load for barge bringing other cargo to Bluff. The discards from grading the decorative aggregate meets the specifications

for concrete aggregate and a stockpile is developing in Bluff. This supplies Allied Readymix concrete plant.

3. "Bryce Hope Group" (*Not real name*), idea of barging aggregate to Nelson then shipping it to Auckland. The enterprise includes a group of about five parties. Vocal group, with big plans, expecting to have operation underway shortly (Stapleton, 2004), (Mathieson, 2004).

8.6.2.3 Recession and Downturn in the Economy

Currently New Zealand is revelling in a buoyant economy. It would be naive to expect this trend to continue without check. Demand projections need to take this into account.

8.6.3 Vertical Integration

Vertical Indication aim's to reduce costs, risks and increase efficiencies of a singular activity. Integration may raise costs by creating inflexibility, especially if suppliers can perform the operation more cheaply. Threats that can be mitigated by vertical integration include:

- Competitor economies of scale
- Supplier bargaining power
    - Especially as demand remains steady and resources diminish
- Buyer bargaining power
- Schedule risks – delayed arrival of materials or contractors
- Transfer of supplier overhead and operating costs
- Supplier product quality
- Incompatible information systems

8.6.4 Differentiation

Although the market demands cost differentiation, competition is driving firms to differentiate through development, quality and improved service. Savings from reduction in overheads and smarter processes are put into technology development and streamlining systems to offer savings to both customer and contractor. Cost leadership usually implies tight control systems, overhead minimisation, pursuit of scale economies and dedication to the learning curve. The experience and quality of personnel alone helps affect timeliness and the costs of a project to be met. A regular review of steps to be taken could highlight opportunities for changes to the schedule. The fundamentals of the adoption and diffusion of product innovation are also relevant. Innovation aimed at streamlining processes and reducing non-uniform standards are also expected to impact the timeliness of product schedules.

8.6.5 Construction Industry Players

The Auckland firms listed below have the potential to be either:

- Customers
- Partners
- Competitors
- Acquisitions or merger partners in order to enable vertical integration
- Aggressors looking to buy and disband competition

<u>Construction Companies</u>

Hawkins Construction Ltd
Multiplex Construction Ltd
Mainzeal Property and Construction Ltd
Fletcher Construction

<u>Large Residential Builders</u>

G J Gardner
Universal Homes
Jennian Homes

<u>Pre-cast Producers</u>

Pre-cast Components Ltd
FormStress Ltd
Wilco Precast Ltd
Hynds Pipes Ltd

<u>Larger Cartage Operators</u>

Mainfreight
Owens
Gleeson & Cox

<u>Contractors</u>

HEB Contractors
Ross Reid Contractors
Downers

<u>Building Supply Merchants</u>

Bunnings
Carters
ITM
Placemakers

<u>Aggregate Producers</u>

Kaipara Ltd
H G Leach
I H Wedding & Sons Ltd

<u>Concrete</u>

Firth Industries
W Stevenson & Sons Ltd
Allied Concrete Ltd

<u>Aggregates</u>

W Stevenson & Sons Ltd
Winstone Aggregates
Fulton Hogan

8.7 Business Strategy

8.7.1 Production Drivers

8.7.1.1 Innovation and Technology

Improved GPS technology allowing better utilisation of delivery vehicles

8.7.1.2 Auckland Developments

- Increase in Auckland Price
- Reduction in Auckland supplies and/or output
- Tighter regulations on
  - Land use
  - Road wear
  - Noise, dust etc
- Decline in service or product quality level
- Positive outcome form current flux and roading politics and governance

8.7.1.3 West Coast Developments

- Increased Industry – mines etc
  - Better transport corridors
  - Better port facilities
- Natural Disaster (Earthquake, Flood, Landslide)
  - Build up of River Channels
  - Council Flood Mitigation Incentives - “There is no monetary incentive offered by WCRC for removing the gravel takes that reduce flood hazards”. (Ingle, 2004)

8.7.1.4 National Developments

- Enlightened changes to the Resource Management Act
  - Consultation process
  - Projects of national importance
- Certainty regarding Seabed and Foreshore ownership
- Progressive Government policy

8.7.2 Time to start up

Entry depends on the level of economic reserves available to the entrant and could be made relatively quickly once the decision had been made to invest and once resource consent had been obtained. If the plant was located in the right areas resource consent would not prevent entry. It is estimated that production could be commenced and the market supplied within 3 months (Reeves, 2004).

8.7.3 Most Likely Scenario

8.7.3.1 Extraction

300 days per year, allowing 9 days per return trip, 33 barges per year @ 8,000T = 264,000T tonnes per annum. This could be increased to a potential 400,000 TPA by reducing turnaround time to 7 days, working 360 days per year and increasing the number of cycles per year. Putting on a second barge would enable production to be raised to the 528,000 – 800,000 range. Efficiencies derived as part of the learning curve, plant improvement, operator skill and changes in both economics and technology in the future could extend the economic aggregate type and volumes substantially.

8.7.3.2 Corporate Structure

The operation would go through a staged development:

1. Sub-Contract extraction, cartage and distribution
2. As tonnages increase debottleneck operation by owning strategic plant (barges)
3. Once sufficient capital is raised begin purchasing distribution centres
4. Organise for other Auckland suppliers to use the company's retail aggregate distribution centres.
5. Ultimately establish a group of separate extraction, cartage and distribution business entities.

8.7.3.3 Government Involvement

1. Initially the barging of aggregate could be subsidised by Transfund's Alternative to Roading Funding (section 9.1.3.1) and Regional Distribution Funding (Section 9.1.5.2).
2. As the operation grows the increased utilisation of railway and port infrastructure should see liaison with Transit, ARTA and NZ Rail. The allow for optimised siting of distribution centres in line with further plans for rail and road corridors and industrial usage zoning.
3. Work with transport authorities to get rail loops from port to extraction and distribution sites.

4. Work with Port and Government authorities to develop Port of Onehunga.
5. Work with West Coast Industry, Government and Ports to establish deep water all weather West Coast Port.

8.7.3.4 Port Expansion Plan

A major new Port on the West Coast has been an idea mooted by 6 successive generations of Westlanders. With the development of bulk export commodities in the region, the need for this proposal to be readdressed is fast approaching. A brief history of past deep-water endeavours is included in Section A1.2. An all weather port would be very beneficial for the endeavour that this project proposes.

8.7.4 Promotion

There goals of promotion

1. Focus on and clearly explain the benefits of the service in as appealing a manner as possible (avoiding abstractions or unwarranted superlatives)
2. Differentiate offerings from competitors
3. Build a good reputation

Vehicles:

- Technical publications
- Industry literature
- Articles in “Management”
- Articles in Newspapers / TV

Considerations

- Quality promised should not differ from quantity delivered.
- Employees proud of jobs achieved are an excellent advertisement for a company’s competency and relationship skills.

8.8 Future Growth

8.8.1 Backloads

One factor that could tip the scales in favour of economic feasibility is a barge backload market from Auckland. The West Coast is rich in resources: water, gravel, scenery, minerals etc. The backloads could bring in a bulk ingredient, which up until now could be the all important seed for establishing major industry or commercial activity. Possible schemes suggested include:

- Cement barging – There is a shortage of General Purpose (GP) cement in Central Otago and Southland, this could be off set by barging supplies from Whangarei.

- Recycled glass from Auckland could be barged to Greymouth for use as a thermal insulation in precast concrete panels.
- Fly ash from Huntly Power Station could be transported to the South Island for use in concrete manufacture.
- Rubbish from Auckland could be barged to purpose built South Island landfills, possibly in relation to backfill mining operations.
- General freight such as cars could be transported to the South Island via Greymouth.

8.8.2 Positive Spin-offs

The back loads could lead to increased industry for the West Coast:

- a hybrid precast concrete factory for quick distribution out of the areas Port
- Plastic bottles, manufactured in Auckland to be filled on the Coast for the global water market (now outselling Coca Cola)
- Increased trade through the ports could see them upgraded, further benefiting the existing large industry in the province.

8.8.3 Distribution Centre Concept

(C/- Whitehorn, 1999) Aggregate demand in the greater Auckland area crates supplier bargaining power. Consequently the entry barrier to a large volume-producing quarry is high. The concept of a Distribution Centre pursues an opportunity based on future suppliers providing alternative modes of transport (barge, rail) into Auckland for the outskirts of the city, Waikato or further afield. The idea is to provide an aggregate terminal with adequate storage capacity in Auckland Central. The benefit in railing the aggregate to the centre is an essential element of the vision. Trucks then visit the centre as per current visits to quarries. As the scheme is a new to the New Zealand quarry industry there are a number of considerations:

- Production planning
- Delivery planning
- Possible system failures
- Inaccurate forecasts
- Unforeseen demand requiring prompt delivery (high time-lag)
- Too much material delivered (esp. by train)
- Storage capacity
- Resource consents for storage and transport options
- Delayed barge travel due to weather
- Unfamiliar loading systems
- Loading windows for barges / trains hired

Market research carried out by Whitehorn showed that customers are most concerned about price, quality and personnel experience as well as timeliness to their contract schedule.

> *"A major threat to contractors is the diminishing aggregate resource in the greater Auckland area, creating significant supplier bargaining power and impacts on distribution channels and transport modes."* (Whitehorn, 1999).

8.8.4 Other Regional Aggregate Markets

The Taranaki-Wanganui area does not appear to contain any significant resources of river gravel or bedrock greywacke. 10,000 TPA of sealing chip is sourced for State Highway work from Manawatu at great expense. Local roads are serviced using inferior volcanic rock derived chip. Also, Gisborne and to a lesser extent Nelson and Marlborough are without sufficient quality local supplies (Christie, 2001). It is economically possible to transport high quality aggregate product by road and rail within New Zealand. Winstone rail Transit NZ grade sealing chip to Gisborne for the summer sealing season. Sealing chip is also trucked from the Wanganui area for use in Taranaki State Highways.

8.8.5 Decorative Aggregate

Natural textures of exposed aggregate especially river shingles are becoming increasingly popular as feature walls, bench tops and driveways. The market for landscaping aggregate exists in Auckland and Wellington. Products need to be distinctive and of good quality. The unit value is potentially much higher than for bulk aggregate though quantities are not large. Southland Sand & Gravel received the small-medium export awards at the Port of Bluff 2002 awards (The Bluff Portsider, 2002) on account of their success in marketing colourful Southland aggregates; as seen in figure 8.1 below. The material finds wide uses including lining swimming pools.

Figure 8.1: Southland Sand & Gravel decorate aggregate range

The following products and prices (figure 8.2a, b, c & d) were found at Phoenix Landscaping Products, Paraparaumu. Management were not prepared to reveal their suppliers, but the prices (more expensive when purchased in domestic scale units) indicate that the market is lucrative. Aesthetic trends are transient and this market niche is not considered long term. The commodity price would reduce if the market were flooded.

a. Franz Josef at $2,000/m^3$

b. Fox & Franz Josef at $1,620 / m^3$

c. Typical West Coast Beach

d. W Coast beach pebble at $1,700 /m^3$

Figure 8.2: Decorative pebbles and City garden centre prices

Winstone Aggregates have experimented with decorative aggregates but the inability to guarantee supply has led to them abandoning the venture (McSaveney, 2004). Shipment of decorative aggregate out of Bluff is typically a back load for a southwards fertiliser shipment.

Table 8.5: 2002 Production of Decorative Aggregate (Crown Minerals, 2004)

Region	Decorative pebbles
West Coast	5,000 t
Southland	13,100 t
Total:	18,100 t

8.8.6 Gravel Extraction in Other regions

Once the source in Westland are at optimal output it may be feasible to supplement supplies from the major alluvial river fans of the east coast of both the North (Hawkes Bay) and South Islands (Canterbury). Currently the Waimakariri River has aggraded sufficiently for the stopbanks to need major increases in height and there are calls for roading projects north of Christchurch to be brought forward in order to perform intensive gravel extraction (Sutherland, 2004). Other suitable sources are mentioned in section 6.1.1. There are good river gravel sources in Southland (Hudson, 1998) including the waste of the Southland Sand & Gravel decorative aggregate grading (section 8.7.8).

8.8.7 Dredging

Dredging of the Ports of Greymouth and Westport occurs on a regular basis. Quality would need to be assessed but the material may be able to be won at a negative cost due to environmental constraints with regard to dumping.

8.8.8 Riprap

Although there is no shortage of hard rock in the West Coast, most of it fractures on weathering. Oligocene limestone is quarried for rip-rap in a number of places. Cobden Limestone near Greymouth was quarried for many years and provided the material for building and extending Greymouth Harbour. One of the few quarries in granitoid rocks was developed at Cape Foulwind where large blocks were used to develop the Westport Harbour moles. There is a demand for large ‘hard’ rocks across the country for river protection works along with decorative uses.

8.8.9 Facing Stone / Dimension Stone

Marshall (1929) listed several local rock types that have been attested and used as facing stone in New Zealand, including the Cape Foulwind Granite, which contains spectacular large K-feldspar megacrysts. Serpentine from the Griffin Range has been used as facing stone and a small amount is still being quarried. This commodity could be developed and marketing in the large centres in New Zealand transported as an ancillary venture.

8.8.10 Greenstone

Traditionally used by Maori for jewellery, tools and weapons and has strong spiritual significance. Modern use is mainly for jewellery and ornaments. In 1997, as part of the settling of historic claims under the “Treaty of Waitangi” ownership of the entire “pounamu” resource was vested in the local Maori tribal group “Ngai Tahu”. This has caused controversy with some locals whose previously granted mining licenses allow them to mine the $9,000/T commodity and their plight is now being heard before the courts. This resource would be lucrative if developed.

9.0 Regulatory and Governance Issues

9.1 Transport Portfolio

9.1.1 New Zealand Transport Strategy (NZTS)

The NZTS is the Government's key strategic transport document from which the Land Transport Management Act (LTMA) and new approaches to land transport are derived. The New Zealand Transport Strategy outlines the government's vision for transport in New Zealand and provides the framework within which transport policy is developed, both for central government, transport agencies such as Transit, and local government. It notes that transport has a key role to play in helping New Zealand to develop economically and socially in ways that protect the environment. The NZTS describes how an integrated mix of transport modes can contribute to economic growth, improved public health, increased safety and personal security, improved accessibility and mobility, and the enhanced environmental sustainability of New Zealand. The NZTS has been developed within the sustainable development framework. The NZTS vision is that by 2010 New Zealand will have an affordable, integrated, safe, responsive and sustainable transport system.

The four key principles of the NZTS are:

1. Sustainability
2. Integration
3. Safety
4. Responsiveness.

The key objectives of the NZTS are:

1. Assisting economic development
2. Assisting safety and personal security
3. Improving access and mobility
4. Protecting and promoting public health
5. Ensuring environmental sustainability.

Such a re-focusing of objectives is a significant move away from the fragmented approach transport that has been followed in the past. The changes resulting from the Government Transport Sector Review will enable the sector take a much broader and collaborative approach to transport planning and management.

9.1.2 Land Transport Management Act 2003 (LTMA)

Transit New Zealand is a Crown Entity established under the Transit New Zealand Act 1989. Its powers and functions were reviewed in the Land Transport Management Act 2003 (LTMA), effective from November 2003, this act changed Transit's principal objective to become:

> *"To operate the state highway system in a way that contributes to an integrated, safe, responsive and sustainable land transport system".*

In meeting this objective Transit must exhibit a sense of social and environmental responsibility which includes:

- Avoiding, to the extent reasonable in the circumstances, adverse effects on the environment
- Taking into account the views of affected communities
- Giving early and full consideration to land transport options and alternatives that contribute to the two points above
- Providing early and full opportunities for the people and organisations (as listed in the act) to contribute to the development of its land transport programmes.

Transit's statutory functions were altered by the LTMA to become:

- to control the state highway system, including planning, design, supervision, construction and maintenance (in accordance with the LTMA and the Transit New Zealand Act 1989)
- to prepare a land transport programme for the state highway system
- to make payments from its land transport disbursement account
- to operate road tolling schemes
- to enter into concession agreements
- to provide the Minister with any information and advice relating to Transit's functions that the Minister may request
- to carry out research, education and training
- To carry out any other functions relating to land transport that the Minister requests or directs.

Changes under the LTMA meant project financing by Transfund now took into account economic development, safety, access and mobility, public health and environmental issues. (Environment Waikato, 2004).

9.1.3 Transfund - National Land Transport Programme (NLTP)

The NLTP is the mechanism through which Transfund NZ allocates funds for the construction and maintenance of New Zealand's road network.

9.1.3.1 Alternatives to Roading

In 1995 the Government amended the transit NZ Act to authorise Transfund to '*fund outputs that consider or develop efficient alternatives to the provision and maintenance of roading*' (Govt.nz, 2004). Territorial authorities, regional councils and Transit NZ are able to submit proposals for Transfund funding, where these are efficient alternatives to roading options.

- ATR provides for funding for efficient alternatives to roading in terms of section 3D of the Transit New Zealand Act 1989. These alternatives may include freight, rail and ferry service operations where these can be shown to meet the requirements of Transfund's evaluation procedures. Capital projects with ATR features may also be included.
- In 2003/04 Transfund allocated $28 million to alternatives to roading
- For alternatives to roading (ATR) projects, Transfund anticipates funding projects in the areas of travel demand management, freight and passenger transport. Simplified evaluation procedures have been introduced for ATR capital projects of $400,000 or less.

9.1.3.2 Regional Development

In 2003/04 Transfund allocated $23.3 million to regional development (Transfund, 2003). Regional development was a new funding group in 2002/03 and is focused on regions with acute transport needs. Projects are identified in an agreed regional transport plan notified to Transfund by the Minister of Transport, Projects may include State highway and local road maintenance or construction projects, and alternatives to roading projects or services.

- Projects are prioritised on a regional level. To be approved for funding a project must:
    - Provide or improve access in such a way that it will encourage direct additional investment in the region
    - Significantly reduce travel costs for industry
    - Mitigate adverse effects on safety, environment and amenity including conflicts with tourist traffic; and/or reduce travel costs.
- Regional development Funding will be provided for projects outside Northland or Gisborne only in exceptional circumstances.
- Regional Development is focused on those projects identified through a regional transport plan agreed by local and central government and industry representatives. These plans focus on the Northland and Gisborne regions because of their acute

transport needs. Projects may include State highway and local road maintenance or construction projects, and alternatives to roading projects or services.

9.1.3.3 Travel Demand Management (TDM)

Transfund has budgeted $53 million for TDM, rail and barging activity class for 2004/05. Under this activity class, potential fundable activities are those focused on:

- Travel demand management, such as work or school travel plans
- Transferring road freight to rail or other transport modes such as inland ports, barging or private forestry roads
- Passenger transport activities focussed on transferring car commuters to rail and bus services such as integrated ticketing and park and ride facilities

Current indicative projects include

- Rail Link to Marsden Point (Northland)
- Auckland rail System Development
- Auckland Rail Rolling Stock Strategy
- Kopu Aggregate Barging (Freight Transport)
- Coromandel Forestry Barging (Freight Transport)
- Te Kaha Log Barging (Bay of Plenty)
- Napier Gisborne rail retention (Hawkes Bay)
- Manawatu Gorge Tunnel Upgrade for Hi-cube Containers
- Log Barging (Marlborough)
- Cobden Rail Bridge Investigation (Greymouth)
- Pike river Coal Mine ATR Investigation (Greymouth)
- Wairio Branch Line (Southland)

9.1.4 Transit NZ Statement of Intent 2004

Goal 1: Ensure state highways (SH) s make the optimum contribution to an integrated **multi-modal** land transport system

Goal 2: Provide safe state highway corridors for all users and affected communities

Goal 3: SHs will enable improved and more reliable access and mobility for people and **freight**

Goal 4: Improve the contribution of SHs to **economic developmen**t

Goal 5: Improve the contribution of SHs to the environmental and social well-being of NZ, including **energy efficiency** and public health

Output Group 4: Regional Development

The objectives are:

- Provide or improve access in such a way as to encourage direct additional investment in the region
- Significantly reduce travel costs for industry
- Mitigate adverse effects on safety, environment and amenity including conflicts with tourist traffic; and/or reduce travel costs.

9.1.5 Changes in Auckland

In December 2003 the Government announced a package to address the unique problems in Auckland and will also provide additional funding for regions throughout New Zealand. The package was conditional on a new governance structure, under the auspices of the Auckland *Regional Council*, to manage Auckland's land transport needs. The new body, the *Auckland Regional Transport Authority*, is accountable for planning and in part for delivering a sustainable transport system which is consistent with Auckland's strategic transport plans. This sets up a unique relationship with Transit, requiring special liaison and communication.

9.1.5.1 Auckland Regional Transport Authority - ARTA

The Auckland Regional Transport Authority (ARTA) was established on 1 July 2004 as part of the Governments "Investing for Growth" program. Previously, the decision matrix for transport initiatives and management was complex as shown in figure 9.1. The new regime looks comparatively streamlined as represented by figure 9.2.

There are two new organisations established: *Auckland Regional Holdings* - ARH will look after assets, like the Ports of Auckland shareholding, and generate funds; and *Auckland Regional Land Transport Authority* - ARTA purchases public transport services and co-funds local roads; they will oversee 'everything' with the exception of State Highways, which are controlled by Transit (Goodwin, 2004). Both organisations answer to the Auckland Regional Council (ARC), ARTA will have a working policy by December and will be operational by 1 January 2005. ARH will inherit all of Infrastructure Auckland's (IA) assets. ARTA will be responsible for many of the transport functions that are currently part of the ARC. ARTA will be responsible for the integrated planning, funding and implementation of all modes of land transport throughout the Auckland region.

ARTA will be responsible for:

- Operational planning of integrated roading and passenger transport infrastructure and services for the region, including consultation as appropriate with Transfund, Transit and "TrackCo"(NZRC) and territorial authorities.
- Funding of Auckland transport projects
- Implementation of operational plans

More specific to this project:

- Planning improvements and developments to the local roading network.
- Long-term upgrades of the rail network including track improvements and additional trains.
- Contributing funds for local roads, along with local councils.
- ARTA's roles and responsibilities will change as the organisation develops.

ARTA will receive funding from the ARC (regional rates and other income from assets currently managed by Infrastructure Auckland), Transfund (funding for approved transport projects/programme) and other revenue – including revenue from services and future travel demand management measures (potentially including road pricing).

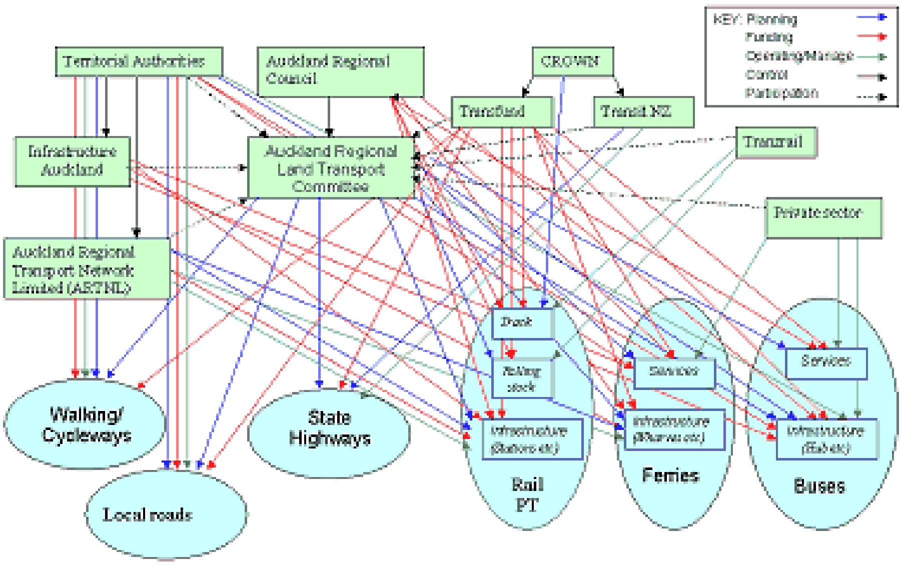

Figure 9.1: Current Auckland Transport Responsibilities

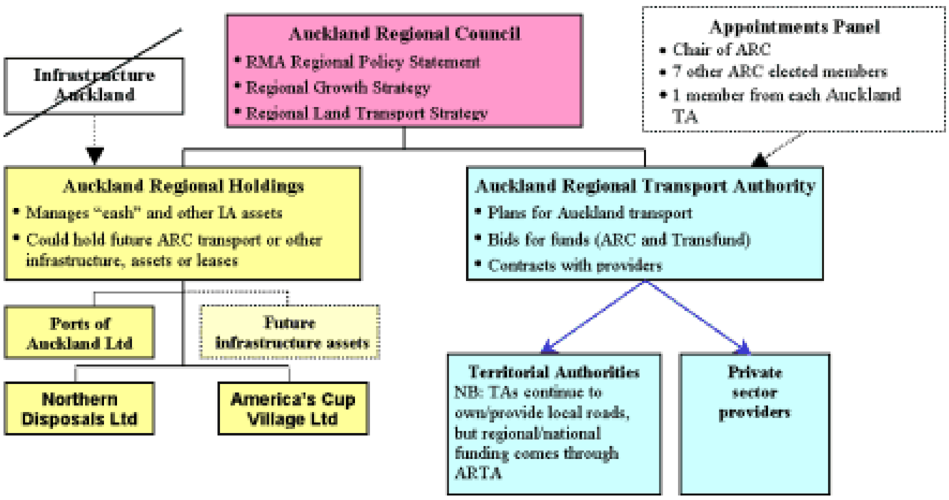

Figure 9.2: New Auckland Transport Responsibilities

9.1.5.2 Regional Distribution Funding - "Investing for Growth"

Investing for Growth is the Governments December 2003 increase in petrol tax package. Additional funding through regional distribution may see roading projects built faster and others added. (Transit NZ, Media release, June 2004). The Government "Investing for Growth" package for the Auckland region includes $1.62 billion in funding over 10 years.

9.2 Resources Portfolio

9.2.1 Resource Management Act 1991 (RMA)

The purpose of the RMA is "to promote the sustainable management of natural and physical resources". This includes land, water, air, soil, minerals and energy including plants and animals and all structures (meaning any buildings, equipment, devices or other facility that is made by man, fixed to the land and includes any rafts). The RMA articulates many concepts of sustainable development, and requires decision-making to take account of a wide range of issues, beyond the strictly commercial.

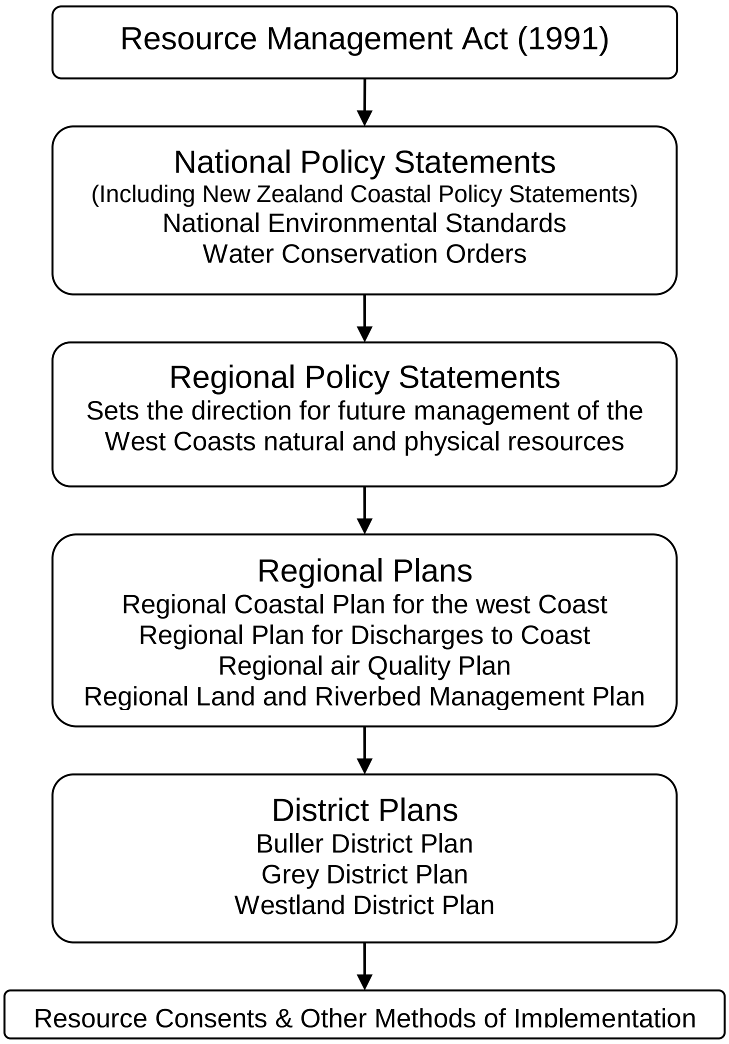

Figure 9.3: Layers of regulation governing gravel extraction on the West Coast

9.2.1.1 West Coast Gravel Extraction

Under the Resource Management Act 1991, in terms of land use, aggregate extraction lies under the jurisdiction of the West Coast Regional Council. The function of the Council is to regulate those activities that may harm the environment by ensuring that resources are used widely and carefully. The council regulates the siting and the amount of gravel being extracted to ensure minimal environmental affect; this is achieved largely by allocation of resource consents. The current policy for gravel extraction states: '*gravel extraction from some river beds is a discretionary activity because there is potential for it to cause significant adverse effects*'. Due to the scarcity of information on the rates of extraction that are sustainable, the WCRC have adopted a precautionary stance on resource consent applications; treating them on an individual basis. When considering applications the WCTC considers a series of matters as detailed in appendix 3. These general conditions establish minimum requirements for granting consents and are changed depending on locality and resource. In short, the current conditions for gravel extraction consents by WCRC make reference to access to the extraction site, maintenance of the site during extraction, maximum extraction volume, method of extraction, rehabilitation of the site at completion of extraction and rights of WCRC. The WCRC currently issue 'global' consents for medium size gravel takes from high-use rivers to speed up the process for local contractors. These consents do not cater for the size of takes this project proposes (up to 1 MTPA). There are no financial incentives from the WCRC council for removing river gravel (Ingle, 2004).

9.2.1.2Auckland Quarries

Auckland City Council (ACC) regulates land use activities while Auckland Regional Council (ARC) responsibilities include air and water quality. Both Councils recognise in their planning documents the importance of aggregates to maintaining growth and developing both the city's and the region's infrastructure.

9.2.1.3 Discontent for the RMA:

In the course of this project the author was alerted to a global discontent for the RMA in the industry.

> "*RMA is the biggest killer of progress*" (Bourke, 2004)
>
> "*It's an exercise in frustration*" (Ganley, 2004)

These casual remarks were reinforced by the more academic forum of the CAE *Oceans Policy* submission to Government (CAE, 2003). The report reported that RMA processes impose significant time and other costs on infrastructure operators seeking consents to undertake investment. There is also often a **high degree of uncertainty** over the likely outcomes of a consent process. Infrastructure operators' basic wish is for high quality and rapid decision making, with a lower burden of time and cost. **This comment was made strongly and repeatedly**. The RMA generally considers only local or regional impacts. In some cases, this may exclude **consideration on the basis of national benefit**. This has implications for optimising the infrastructure stock if consents for infrastructure investment are driven more by local than national considerations: an optimal national stock may not be optimal for each and every region. Objectors, including those perceived as having dubious standing in some cases, were widely seen to be **unduly empowered by the act**, leading to a "payoff" culture that is widely considered to be unsavoury (CAE, 2003).

An example of a number of the disappointing aspects of the current RMA is portrayed by the outcome of two coastal log barging proposals in Northland. Following recommendations in the Northland Integrated Transport Study report calling for investigations into alternative transport methods to roads; including options such as barges and rail to carry increasing log volumes from Northland forests as a way to relieve pressure on the region's often-congested and substandard roads; tentative proposals were made for coastal barging from Unahi in the Rangaunu Harbour, from Totara North in the Whangaroa Harbour and from Port Whangarei. One of the operations involved two 3000T capacity barges, one covered and one uncovered, to carry logs and forestry products from Kaimaumau down the east coast to Marsden Pt, near Whangarei, each week. The proposal involved building a loading wharf beside a storage area and terminal at Kaimaumau on the harbour's western side. A second terminal would be built at Marsden Pt to discharge log cargoes for export or for further processing. All three proposals involved barging logs cut from the region's maturing pine forests to the newly developed deepwater port at Marsden Point. This fell within the Alternatives to Roading (ATR) Transfund funding class and both the Regional Council and Transfund shared the $40,000 cost of a study into the economic viability of barging logs from Kaimaumau down the Northland coast to Whangarei. Who, along with Transit NZ were enthusiastic about the ideas and forestry companies (JNL) had supplied letters of intent. The sustainable forestry asset of Northland was set to be 'sustainably' barged to port with minimum impact on the regions roads. The barge company having invested a month putting together a proposal were faced with the news that the Regional Council was no longer considering the proposals due to "significant concerns of local community members about the barging proposals and the information they had provided the Regional Land Transport Committee had been factored into the Subcommittee's decisions" (Northland Regional Council Website, 2004). *The Northern Advocate* published a letter that closed with the following line: "We will do whatever we have to ensure that log barging never occurs at Totara North or elsewhere in the Whangaroa Harbour" (Tuckey, 2004).

9.2.2 New Zealand Oceans Policy

In July 2000, the Government agreed to the development of an Oceans Policy for New Zealand. The policy would ensure integrated and consistent management of the oceans within New Zealand's jurisdiction. Covering all aspects of oceans management, including effects from land, and would extend out to the edge of the Exclusive Economic Zone and the Continental Shelf beyond. The completion of the Oceans Policy package has been delayed so that it can take account of Privy Council hearings on public access and customary rights to the foreshore and seabed.

The Oceans Policy initiative is explicitly searching for the best ways to pursue economic opportunities within New Zealand's oceanic territory. It sets out to:

- Propose how the ocean should be governed
- How to mange the health of the ocean
- Examine the oceans contribution to the present and future social, cultural, environmental and economic well being of New Zealand.
- Provide more coherence in legislation and management relating to use of the oceans as current laws are complicated, piecemeal and contradictory.
- Be a comprehensive policy to help resolve conflict between different human uses of our oceans

9.2.3 Foreshore and Seabed Endowment Revesting Amendment Act

The Department of Conservation's ownership role is dealt with under the Resource Management Act provisions for tendering of coastal occupation, reclamation or sand and gravel extraction, where competition exists for the resource. Coastal rentals for extraction continue to be collected for the Crown

9.2.4 Iwi (Maori Tribe) Issues

9.2.4.1 Consultation under the Resource management Act

The Resource Management Act requires local Maori tribes to be consulted regarding any proposal that falls under the act.

- Due to the overwhelming number and bureaucratic nature of the consent consultation ritual, a number of tribes have sub-contracted the matter out to "Iwi Consultants".
- Tribe policies on activities are unknown, unwritten and not derived from consultation and consensus; causing major unknowns for industry.

- Limitations are not necessarily revealed, even when asked, opening the way for last minute significant announcements and associated set backs. (Northland Port Corporation, 1998).

9.2.4.2 The Ngai Tahu (Pounamu Vesting) Act 1997

The Act vested ownership of all the South Island's ponamu / jade / greenstone to the Nga Tahu tribe. This was part of the Crowns' final settlement of grievance claims of the tribe in 1998. Nga Tahu has published guidelines for procedures in the event that pounamu is unearthed by a contractor (Pounamu Management Plan, Nga Tahu website, 2004).

9.2.4.3 Foreshore and Seabed Bill

Uncertainty regarding ownership of foreshore and seabed is seen by industry as a major uncertainty and a surety to frighten investors. In a submission regarding the proposed legislation The New Zealand port companies stated that they believed that both Customary Rights and the Ancestral Connection provisions have the potential to, and probably would, result in much higher compliance costs, litigation and rent seeking behaviour.

9.3 Infrastructure Portfolio

9.3.1 Ministry of Economic Development Infrastructure Stocktake

This Government initiative announced in the 2003 Budget key purpose was to assess the quality of New Zealand's energy, water, transport and telecommunications infrastructure and the extent to which it contributes to or represents a barrier to achieving the Government's economic growth and sustainable development objectives. It also aims to establish principles to guide government decision-making. Given the breadth of the brief, the evaluation has been undertaken at a relatively high level. The approach has been to:

- Assess the condition of the existing assets
- Evaluate the extent to which the infrastructure meets current demand
- Assess whether infrastructure is likely to be able to meet demand in the future, and the responsiveness of the infrastructure to changes in demand going forward
- Provide some high level commentary on the sustainable development implications of the current and expected infrastructure stocks
- Raise issues identified during the project for consideration in policy-making
- Provide a potential indicator framework for further development in the future

9.3.2 New Zealand Railways Corporation (TrackCo)

In recent years there have been several key developments in the rail sector: In late-2001 the Crown acquired Tranz Rail's Auckland rail infrastructure assets. In 2003 the Crown negotiated a heads of agreement with Tranz Rail that envisaged the split of Tranz Rail's business into an operating company, and a rail infrastructure business that would be acquired by the Crown. Later in 2003 further negotiations occurred with the Australian company Toll Holdings, and the Crown entered into a revised heads of agreement with Toll Holdings - on substantially similar terms to the previous agreement. Toll Holdings acquired a majority shareholding (around 85%) in Tranz Rail, renaming it Toll NZ.

Figure 9: Decrepit rail infrastructure at Penrose Junction, Auckland

On 30 June 2004, a series of agreements giving effect to the Heads of Agreement were executed, including:

- a Sale and Purchase Agreement for the transfer of rail infrastructure assets to the Crown for payment of $1;
- a variation of the existing Core Lease for land, that saw much of the Crown land previously leased to Toll NZ relinquished;
- a commitment by the Crown to invest $100 million on replacement of rail infrastructure assets, and a further $100 million on upgrading the rail infrastructure – with Toll NZ in return being committed to spend $100 million on new and refurbished rolling stock; and
- An Access Agreement providing Toll NZ with exclusive access over the Network, with limited exceptions and subject to certain conditions, in return for payment of a track access fee calculated on a cost-recovery basis.

On 1 September 2004 the Crown transferred these assets to the Corporation, along with responsibility for giving effect to the Crown's agreements with Toll NZ. Staff related to rail infrastructure operations also transferred from Toll NZ. In late-2003 the Crown acquired the Wellington Railway Station, which will also transfer to the Corporation. The Corporation will initially continue under its current statutory framework, (statutory corporation, and a State Owned Enterprise) but expects that Parliament will shortly change it to a Crown entity. It is largely based in Wellington, but has a small Auckland and South Island representative presence. The next few years will be busy and challenging for the Corporation. The primary focus for the remainder of 2004 is to finish transition work and to establish the NZRC as the entity with the skills and capability to run the rail network efficiently, effectively and safely. However, the work has already commenced that will ensure that the Crown's rail strategy will be aligned with other transport modes, so that the rail infrastructure makes an effective contribution to New Zealanders having access to an efficient and effective transport system.

10.0 Environmental Considerations

10.1 Fluvial & Coastal Sediment Dynamics

10.1.1 Aggradation

The main characteristic of many of the region's rivers is that they consist of wide gravel beds in their lower reaches, High rainfall and flooding, combined with the prevalence of easily eroded rocks east of the Alpine Fault, producing high rates of sediment supply in mountain and glacier fed rivers. Rock avalanches, triggered by tectonic activity, intense rainfall, or the result of spontaneous slope failures, have also contributed to huge volumes of materials entering riverbeds. The random and unpredictable nature of these events can result in a large and rapid increase in sediment yields. Similar outcomes may result when a river migrates laterally and gravel is moved from one side of a bed to another or when glaciers, such as the Franz Josef Glacier/Waiau, advance (Davies et al., 2003). Frost shatter and heave, along with scree and gully erosion in the mountains are other processes which contribute to sediment supply, while glaciers are another source of eroded material that is transported by rivers in the south of the region. These processes cause large quantities of gravel and finer sediment to be transported, some of which is deposited once rivers emerge from the mountains onto their floodplains. The process of gravel transport and deposition is complex. Deposits of gravel in riverbeds are reworked during floods, as they move downstream. Thus a riverbed can act as both a store and a source of gravel. Episodic events such as rock avalanches, earthquakes, or intense rainfalls can elevate the volume that is transported. During a December 1995 storm event there was approximately 5m of aggradation in the central flood plain in the upper Waiho River valley, this equates to an estimated 225,000m^3 of material (Turnbull, 1998).

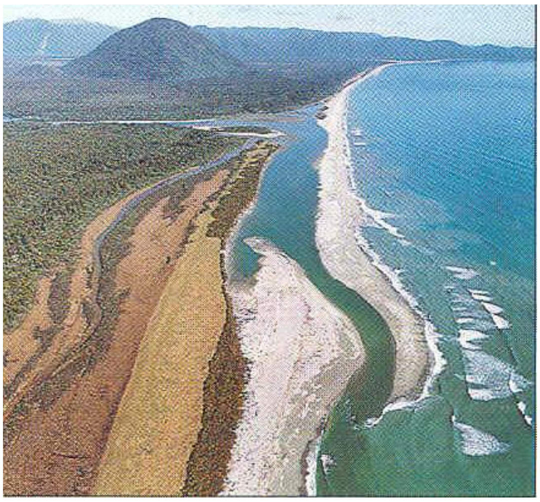

Figure 10.1: Long-shore drift affecting mouth of south Westland river

On the region's flood plains, courses of rivers could change freely as a result of channel migration and sedimentation. As the population increased these natural processes of erosion or deposition did not give the desired predictability sought by communities. Until 1987 generous government subsidies were available for flood protection works. The national philosophy behind the erection of those structures was that flood protection should not just protect human life and property, but also encourage improved utilisation and productivity on flood plains. This amounted to 210 km of stopbanks on the West Coast. Central government no longer provides such funding (WCRC, 2004).

10.1.2 Littoral Drift

The drift of material from south to north along the West Coast takes place all year round; the quantity travelling is heavy and the supplies inexhaustible. The material is sourced from the gravel washed down from the Alps in rivers. The sea waves transport by acting on the beaches and sea bed. The southwest swell raised by the south western winds prevailing in the 'roaring forties' latitudes persists in varying degrees throughout the year and keeps the materials on the move by rolling the coarser materials up and down the beaches and putting the finer materials into suspension so that they can be carried by the combined action of the waves themselves and of the northerly set which is induced. The rate is greatest in rough weather and during comparatively calm conditions. Materials remain stored where they were last dropped waiting to be moved during the next rough sea. The amount of material being moved appears to be relatively constant all the way up the coast and persists not only along the beaches but past cliffs and headlands where there is comparatively deep water, the greater turbulence on these parts of the coast enabling the material to be carried forward on the sea bed without formulation of beach stretches (Rendel et. al., 1946).

At Cape Farewell at the extreme north of the island where the west coast terminates, the stream of drift has built out a long sandy spit extending in an easterly direction for over 20 kilometres (1946), 30km (1976) and it is slowly spreading, lengthening and widening until it is now 35km (2002) and growing every year.

Figure 10.2: Farewell Spit from space and looking from Cape Farewell

Although it is next to impossible to accurately determine the volume of material moving up the coast, a 1946 calculation of 3.8 million m^3 of material being carried up the coast a year is accepted as indicative of the order of magnitude (Rendel et al, 1946).

10.2 Impacts of Extraction

10.2.1 Gravel Extraction

The extraction of aggregate material from both the inactive flood channels and the active flow channels has an environmental affect on both the properties of the river and the wildlife in the surrounding areas. Dangers include direct destruction or disturbance of aquatic life (Crushing or removing breeding grounds of fish and birds and/or destroy habitat), indirectly suspended sediment clogging spawning beds and disruption of feeding areas for fish and birds, noise from machinery may disturb nesting birds. Research undertaken by Hudson in 1998 into the impacts of gravel extraction on the physical and environmental effects of South Island rivers is summarised in table 10.1 below.

Changes to the river flow dynamics such as through removal of bed material, may result in a change to the river’s hydraulic processes. Changes may cause the flow to be deflected resulting in bed or bank erosion, changes in stream power, or flooding downstream. West Coast rivers often have associated wetlands. The natural balance of ecosystems present in wetlands can be very sensitive to activities both in the bed and those affecting the adjacent land. There are a number of rivers and wetland beds on the West Coast that are of significance (WCRC, 2004).

Table 10.1: Effects of gravel extraction on river systems (Hudson, 1998)

Physical Impacts	Environmental Effects
Removal of Bed Material	
• Release of interstitial fines from bed materials (beneath armour layer)	➢ Extreme sediment concentrations may adversely affect fish and other wildlife ➢ Removal of fines may lessen opportunities for vegetation colonization ➢ Suspended sediment deteriorates water quality for municipal, agricultural, industrial and recreational uses
• Selective removal of particular size bed material	➢ May remove or add to suitable substrate for fish spawning, micro fauna/flora, and bird ➢ Disruption of primary productivity ➢ Direct mortality to flora and fauna (a positive element may be the removal of nuisance species)
• Scraping bar surfaces for aggregate supply	➢ Wider, flatter river increases stream temperature, decreases oxygen… ➢ Decreases diversity of river bed ➢ Change the river character (recreation, access, aesthetic…)
Riverbed Degradation	
• At a local, reach and river system scale - Degradation upstream with headward retreat - Downstream degradation with sediment starvation -	➢ Change in the habitat types and availability ➢ Undermine infrastructure (bridge, bank protection…) ➢ Strand water pumping facilities
• Stranding tributary systems - promotes headward retreat - creates knick point	➢ May stop passage of fish
• Change in hydraulic regime • river becomes more confined frequency of inundation decreases for backwaters, higher channels	➢ change in suitability of habitat (e.g. velocity depth relationship change which may effect habitat suitability) ➢ Changes access to riverbed.
Decreased Channel Stability	
• Scraping bar surfaces for aggregate supply	➢ Increased frequency of channel shifts might destroy or create habitat ➢ Removal of scrub will offer some bird species more habitat and lessen predation
• Bank instability through undermining	➢ Provision of food and nutrients to river ➢ Loss of riparian margin/productive land

Extraction of bedload material from the active channel or flood plain of a major gravel-bed river may have the following environmental impacts:

- Changes in profile geometry involving an overall lowering of the active bed or floodplain, with consequential erosion and incision, if natural supply does not meet the extraction rate
- Bed changes could result in scour around bridge piers or other infrastructure assets, and/or alter replenishment, so that river protection works become undermined.
- Certain minor ecological changes can be expected due to noise and disturbance from extraction site. The generation of fine sediment (sand and possibly mud) is likely for extracting materials below the armoured surface.

- The operation may involve on-site screening and the return of disturbed fine and course material to the river bed or active floodplain.
- Sediment re-entering the channel could impact on aquatic species including change to their habitat.
- Prolonged over-extraction could result in bank erosion and collapse, which in turn could cause more widespread habitat changes as well as loss of riparian land. A degradation sweeping up stream is a further possibility that ultimately leads to upper catchment erosion.

10.2.2 Quarrying

The overall effects of extractive operations can diminish landscape appeal, induce or accelerate erosion, alter water quality and reduce the suitability of land for future uses. The Geological Society of New Zealand has prepared inventories of significant geological sites. These detail much of Auckland's landscape "endangered" by extraction. Mineral extraction is often incompatible with ideals such as the preservation of distinctive natural landforms that have scenic, historic, cultural, recreational, environmental or scientific importance.

Figure 10.3: Wiri Quarry and the remains of the Manurewa Volcano Cone

In Auckland aggregates are extracted through quarrying. Such operations result in many undesirable adverse environmental conditions:

- increased traffic
- noise
- vibration
- visual intrusion
- dust

- generation of derelict land
- Silt run-off and sedimentation ponds
- Groundwater contamination
- Excessive Road Usage
- Water table draw down

Further disadvantages include:

- Neighbour consents
- Access
- Consent from local Maori
- Rehabilitation Costs

10.3 River Bed Management

Poorly managed activities can increase the rate of erosion of riverbeds and banks, change the alignment of river channels, cause loss of land, undermine stopbanks, and increase maintenance costs. There is a need to ensure that when activities are undertaken the integrity of structures is retained, particularly those pertaining to network utilities (roads, railway bridges, telecommunications, and electricity). In some cases this will require the removal of accumulated debris away from structures in order to retain their integrity, whereas in others, controls on activities, such as the rate of gravel extraction may be required to ensure that excess or inappropriate activity does not cause scouring or erosion of structures.

The results of Temple's 2001 (Temple, 2001) study of the West Coast river gravel resource with respect to the sustainability of gravel extraction, appropriate rates of extraction, monitoring and expected replenishment of the resource are summarised below. Bed material replenishment in the Grey and Whataroa Rivers is at least matching present gravel extraction rates. Major bank and channel changes in historic times indicate more than adequate supply of sediment. Neither the Whataroa nor Grey Rivers presently have significant environmental impacts in terms of bed or active floodplain extraction. The Inangahua River will require more careful management because data to date suggests only minimal replenishment is occurring. All rivers for which gravel extraction is planned should be monitored by means of regular surveyed profile lines and accurate records of extraction (Temple, 2001).

10.3.1 Whataroa River

In the central Whataroa catchment, some 230 Ha of riparian land has been lost to bank erosion from a river length of 15km during the last 52 years. The environmental changes accompanying such significant natural bed and channel changes are similar to those accompanying moderate to large scale gravel extraction (25,000 m^3 /year). Given that the present extraction rate is only 2,000 m^3 /year from one location and that there is clear evidence of natural replenishment, the environmental impacts of the current operation on the Whataroa are considered to be minimal (Temple, 2001).

10.3.2 Grey River

The Grey River has two separate areas in terms of potential for gravel extraction, a lower catchment downstream of Dobson and an upper catchment above Stillwater. In the lower catchment substantial extraction (of the order of 10,000m3/year) occurs at Racecourse Bend, and profile monitoring confirmed active bed movement and gravel replenishment without significant environmental impacts. In the upper catchment there is only limited current extraction at Mawheraiti, but significant potential exists for large-scale extraction in the central part of the river between Ikamatua and Stillwater. Substantial bank, bed and channel changes are occurring naturally in this section of the Grey, and again environmental impacts of extraction would be minimal with the added benefit of improved channel capacity to pass high flow events without damage to the river protection works (Temple, 2001).

10.3.3 Inangahua River

The Inangahua River is a somewhat smaller river, than the Grey in terms of catchment area and river flow, and is also divided into an upper and a lower catchment separated by a bedrock gorge. Current extraction is limited to Craig's Clearing site, and profile monitoring indicated only bed movement at the Andersons Road site near Reefton. The frequency of bed material movement and natural replenishment may therefore be lower on the Inangahua, with consequential implications for general extraction. In particular, the presently available data suggests that the environmental effects such as bed degradation are potentially more severe on the Inangahua than on either of the other rivers (Temple, 2001).

10.3.4 Waiho River Example

The Waiho River is a short-run glacial river on the Southern Fault Line in an area of very high rainfall. Franz Josef is very prone to a catastrophic event either as a result of a flood in the Waiho River or a dam break (from a landslide) in the Calley Gorge upstream from the township. The community next to the Waiho River and the south bank in particular, is very vulnerable to a failure in the current flood protection systems. If there was a breach in the early morning there could be a large loss of life due to the swiftness of the river and its extremely cold temperature. Franz Josef Glacier is a national icon. It draws international visitors to New Zealand's South Island and plays a major role in the economy of South Westland. The permanent population of Franz Josef village is 270 but on some days there can be up to 2000 mostly international visitors staying overnight. A camping ground, motels and lodge are on the lee of the stopbanks on the south side of the river.

Figure 10.4: Temporary State Highway Bridge and Waiho River festooned with aggregate

The Waiho River has been aggrading at a rate of 300mm/year for half a century. The riverbed is now 2 m above the surrounding land. Stopbanks were constructed in the 1980s to protect the community from a 1-in-50-year flood event but these are unlikely to provide protection today from a 1-in-10-year event (figure 10.4). Westland District Council has, as a variation in its District Plan, land-use controls that prohibit further development in the areas most vulnerable to flooding in the Waiho flood plain. This however does not address the current properties and businesses. The West Coast Regional Council has installed flood-warning systems up-river from the township (MfE website, 2004).

The Cost of Waiho aggradation issue to date:

- In 1995 floodwaters eroded the northern abutment of the State Highway 6 Bridge over the Waiho River.
- Widening in the upper valley has resulted to damage to the Franz Josef glacier access road in 1965, 1972, 1979 and 1984. (Turnbull, 1998).
- The Government has assisted the businesses affected by the hazard warning, imposed due to the Waiho River aggradation, to relocate with an assistance package of $1.1 million and $1 million in low interest loans.
- A 2002 Civil Defence report described the risk of a sudden and uncontrollable flood caused by a "dam-break" event where a landslide into the Callery Gorge could dam and break, releasing a wall of water and gravel 1.5 – 2m deep through the stopbanks

and accommodation areas with virtually no warning. In heavy rain the landslide, damming and release could occur within as little as 1-2 hours.

10.3.5 Mitigation of Adverse Affects

Extraction from the inactive flood channels has a less direct effect.

10.3.6 Benefits of Extraction

Floodplain widening and associated aggradation of river beds can cause over bank flow during high discharge events. There are current flood mitigation and gravel build up concerns in the flood prone south Westland rivers, with gravel removal having beneficial effects (Daniel, 2004). Removal of gravel and wood from riverbeds (including rock, sand, and finer material) is necessary in a number of cases and important for people and communities of the West Coast. Regional Council records show that on the basis of past allocations, there is little to suggest that resource depletion has been, or is an issue, except for a few small rivers where natural transport rates are low. The WCRC Land Rules (WCRC, 2004) allows persons to carry out low volume extraction of gravel from certain riverbeds as a permitted activity.

10.4 Barging

Advantages of barging include reducing heavy traffic on state highways and improving road safety and congestion. In 2003 there were 62 fatal accidents involving trucks on New Zealand (source: LTSA).

11.0 Comparable Operations

11.1 Existing Barge Operations

The author has identified 5 existing similar aggregate barging operations, two of which are described in separate sections below:

1. Mt Rex Shipping (Atlas Concrete) barging baserock the length of the Kaipara Harbour for the company's internal concrete aggregate needs, detailed below in section 11.1.1;
2. Leaches barging operation (in consents stage), moving aggregate from Kopu in Thames Valley to Auckland.
3. Stevenson's barging aggregate from Kauiua, south east of Auckland to the company's Silverdale concrete plant.
4. Southland Sand & Gravel barge backload decorative aggregate from Southland to Auckland.
5. West Coast Rock Group move Greymouth beach gravel to Auckland for use as decorative aggregate.

11.1.1 Atlas Resources Quarry Pt to Mt Rex Baring Operation

The Atlas Resources operation at Hukatere Quarry and the subsequent barging and processing at Mt Rex, in Helensville is depicted in figures 11.1 to 11.1 below. Atlas is a $60M concrete ready mix, sand dredging and quarrying company. It is a family group of companies operated by the Collie family since 1962. A 41% share is currently being purchased by Holcim (NZ) Ltd.

The 2,000T *Kaipara Karrier IV* transports AP100 base metal from a purpose built landing at *Quarry Point Ltds'* (An Atlas subsidiary) Hukatere Quarry near Tinopai in the north eastern reaches of the Kaipara Harbour It is loaded by a purpose built conveyor system directly from the base of an awaiting stockpile. A return trip for the self propelled barge over the 60 km stretch takes 3 days. It is unloaded at *Mt Rex Shipping Ltd's* (a wholly owned subsidy) sand dredge landing at Mt Rex, Helensville by 30T conventional excavators. It is crushed and graded there and then trucked 25 kms to Silverdale for use in Atlas Concrete Ltd readymix concrete.

The Mt Rex site is serviced by State Highway and the North Auckland Rail Line. This scheme has seemingly not attracted as much public scrutiny as could be expected possibly due to the harbour not being widely used by recreational mariners (Ganley, 2004).

Figure 11.1: Hukatere Quarry, North Kaipara Harbour

Figure 11.2: 40T dump trucks cross the road at a special concrete strengthened intersection

Figure 11.3: 29mm wide key tag indicated size of transported base rock

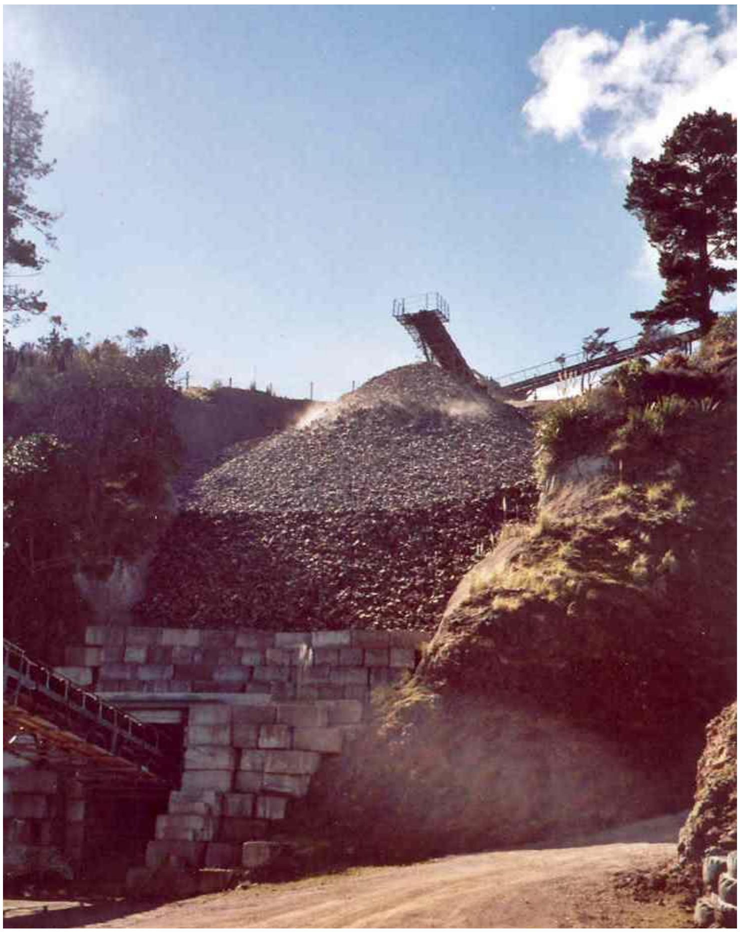

Figure 11.4: After the primary crushing, base rock is stockpiled awaiting return of barge for loading. Notice the conveyor exiting the base of the stockpile

Figure 11.5: Barge loading conveyor boom is on a turntable so that it may be rotated out of harms way between barge visits.

Figure 11.6: Wharf set-up showing off-piers to maintain barges position when docked. Service sheds are painted green, apparently to blend in with the environment.

Figure 11.7: Kaipara Karrier IV, DWT 2,000T, self propelled deck-loading barge

Figure 11.8: Map of Kaipara Harbour showing the 60 km Quarry Pt to Mt Rex barge route

Figure 11.9: Strengthened deck of barge, residue base-rock and two conveyor loading bins

Figure 11.10: Unloading conveyor set-up, notice the proximity of the muddy foreshore

Figure 11.11: The Mt Rex base rock stock pile at Helensville. From here it is processed further and transported to Silverdale for use in Atlas Readymix concrete

11.1.2 Leach Quarry Products Barging Operation

HG Leach & Co. Ltd is a privately owned family company having a 50 year history in the Thames Valley. It operates four quarries at Tirohia, Matatoki, Tahuna and Waitawheta and manages refuse transfer stations and landfill disposal for local authorities. HG Leach have an extensive road fleet for transporting aggregate in constant operation across the North Island, moving aggregate from the Thames Valley quarries to projects in Auckland, Tauranga, Hamilton and the Coromandel.

In order to meet the needs of the ever expanding Auckland market, HG Leach has RMA consents to develop a barging transport system based in Kopu, with the aim of improving the company's turnaround time on bulk aggregate orders. The barge-loading terminal at Kopu will see 40,000 TPA of aggregate from Matatoki Quarry near Kopu run a direct route up the coast to Selwood Rd, Henderson, Auckland; the 600T - 1000T barges taking as much aggregate in one trip as 35 truck and trailer loads. Eventually, HG Leach intends bringing dredged marine sand back from Auckland for use in the Coromandel concrete market. This amount of aggregate would remove 1,400 truck and trailer trips from state highways per year. At present this operation is not economically viable, due to the double handling required. Transfund's assistance was sought to provide funding over three years to get the operation established. Transfund has approved funding of a feasibility study.

Transfund are taking a high level of interest in the project as it would be setting a precedent. Under the travel demand, management, rail and barging (alternatives to roading) activity class an application for funding the ongoing barging of aggregate from Kopu to Auckland is currently with Transfund (Environment Waikato, 2004) The project has an Efficiency ration of 1.79 and as this is greater than 1.0 it is eligible for consideration by Transfund. Transfund, the Government agency which funds roading projects, has $53 million available in its 2004-2005 budget for alternative road transport, and has already approved $400,000 for a barging operation in Marlborough.

11.2 United States Aggregate Shipments

In the U.S. lake and ocean freighters have recently become an efficient means of transporting aggregate. In the Great Lakes region aggregate is often moved through the use of hopper barges commonly holding 1,500 tons each and travelling in groups of 30 or 40 barges. Along the Atlantic and Gulf Coasts, where local supplies of good quality aggregate are in short supply, aggregates are imported from Mexico, Scotland, Canada and other countries.

Transportation by ship is possible in part because of back-haul pricing (PitandQuarry.com, 2004).

Conflicting land use issues along the western seaboard of the U.S.A. currently see many building materials, including aggregate, sourced from quarries in British Columbia and further afield (Starrat, 2003). The key to this market is the development of low-cost water-borne transportation, through the use of large and efficient ships and bulk handling systems. The result is that these imports are augmenting local supplies of building materials all the along the U.S. West Coast, at a cost that is becoming competitive, especially when sand and aggregate are marketed as superior quality to the local product. Gypsum bulk carriers from Mexico, supplying up into Canada, now backhaul aggregate to San Francisco and Los Angeles, resulting in a substantial change in the economics of moving both northbound gypsum and southbound aggregate.

An important factor in establishing this scheme was the development at Sechelt, 50 km north of Vancouver, of a vast high quality aggregate quarry to supply the Puget Sound construction market by barge. Deepwater facilities located alongside the quarry give 15m of water. Aggregate is loaded onto Panamax sized bulk carriers at 4,000 tonne per hour using a bulk loading system. The keystone of this enterprise is the self-unloading vessels developed by Canada Steamship Lines on the Great Lakes that discharge at the rate of 5,000 tonnes per hour by a 75m telescopic boom. This equates to unloading an entire Panamax 70,000T ship in one day. In 2002 800,000 tonnes of aggregate and sand were brought into the San Francisco bay area and 700,000 tonnes of construction rock and aggregates into the Los Angeles/Long Beach area. Self-unloading vessels make shipments on a monthly basis, to purpose built unloading facilities at San Francisco.

11.3 United Kingdom Aggregate

In the U.K. 30% of the countries aggregate is sourced form coastal quarries or by dredging and as a result where water access is available barging is an increasingly popular mode for haulage over 100km. In the southeast of England 30% of all aggregates produced are now mined from the sea bed.

11.4 Portland, Oregon, U.S.A. - "Rock by Rail"

To address relegation of quarry activities to remote locations, Morse Bros. Inc. (MBI) run a rock-by-rail operation, shipping train loads of aggregate from its Salem pit, about 50 km south of Portland, to unloading points around the city. The Portland area population is expected to increase by 40% by 2017. The US$6.4 million project is configured to handle 2/3rds of Salem's 1 MTPA + production. Instead of roughly 14,700 truckloads needed to ship about 500,000T of aggregate into the Portland area, the job is done with 260 train loads. A rail siding was constructed at the MBI yard and another was required to link their quarry load out facilities to the main line.

11.5 Cement Sea Barging

11.5.1 Holcim (NZ) Ltd

Two cement bulk carriers, *MV Milburn Carrier II* and *MV Westport* transport cement from silos at Westport to 8 marine terminals, located at Onehunga, Napier, Gisborne, Wellington, Nelson, Lyttleton and Dunedin. Modifications allow both vessels to carry used oil products from around the country back to Westport to be used as fuel in the clinker kilns. The vessels are loaded at an average rate of 600 tones per hour and discharge pneumatically between 180 and 330 tonnes per hour; they make 144 visits to Westport combined per year, loading out 450,000T of cement per annum.

Figure 11.12: Cape Foulwind cement and marl quarry

11.5.2 Golden Bay Cement Ltd

The company's manufacturing operations are concentrated at Portland, 8km south of Whangarei. Cement production has taken place at Portland since 1916 (MED, 2001) Portland's raw materials are quarried from two substantial seams of limestone, one behind the Portland plant and the other 32km north at Wilsonville. From Portland bulk cement is distributed to Golden Bay Cement's eight Customer Service Centres around New Zealand, and then trucked to customers. The company's supply ship, *MV Golden Bay*, maintains silo levels at five ports around New Zealand. The National Support Office, which also serves as a centralised order and distribution centre, is in Auckland. (100% owned by Fletcher Challenge Ltd) annual limestone production capacity of 600,000 tonnes and cement is 490,000 tonnes per annum.

Figure 11.13: Golden Bay Cement mine, factory and jetty.

11.5.3 Fern Cement Ltd

Fern Cement Ltd was established in Wellington early in 1997 to offer an independent alternative for the concrete and allied industries that only had the choice of 2 cement distributors, who are in the main, competitors to their clients, whilst Fern Cement is only in the import and distribution side of the industry. Fern Cement has distribution depots in Auckland, Bay of Plenty, Hawkes Bay, Christchurch and Timaru and Dunedin. Cement and Fly-Ash is available from these depots in 2 tonne, 1.5 tonne, 40kg and 25kg bags and by bulk road tankers.

11.6 Shakespeare Bay

Shakespeare Bay is the deep water port facility opened in April 2000 in the adjacent bay to existing port facilities in Picton Harbour at the southern end of Queen Charlotte Sound. The new development enables the port to accommodate vessels of all sizes and reflects the growth in export bulk cargo coming available within Marlborough and the need for storage and shipping facilities capable of handling large volumes of timber, logs, and coal. The local forestry resource is nearing maturity, and the West Coast coal resource provides a potential cargo requiring access to a deep water export port.

Figure 11.14: Shakespeare Bay, Picton 2004

The 200 metre long Waimahara Wharf is designed as a multi purpose berth with the ability to be extended northwards as demand requires. With a depth alongside of 16 metres at low tide, Shakespeare Bay provides the deepest export berth in New Zealand. The addition of mooring dolphins will allow Panamax vessels to be accommodated and future development includes extension of the wharf to 300 metres and further dredging to accommodate Cape size vessels. Quayside storage of 10 hectares of flat open area lies adjacent to the berth and can be accessed by road, rail and coastal shipping to allow cargo consolidation prior to shipment. The area is fully lit to allow loading 24 hors a day. An additional storage area is also available for development. Port activity is screened from the township of Picton by a bush covered ridge.

11.6.1 Coal Barging

After Solid Energy announced that it was not continuing plans for the proposed coal jetty at Granity the ports of Westport, Greymouth and Marlborough introduced an initiative "Coast-Link-Coal", to barge coal from Westport and Greymouth to Shakespeare Bay near Picton for direct loading onto deepwater vessels for export. Investigations include developing initial coal handling facilities of up to 500,000 tonnes per annum (around 60 barges a year) at the port. Barging from Greymouth and Westport to Shakespeare Bay could see eight Panamax vessels visiting the port every year, with up to 1.5 to 2 million tonnes of coal exported annually. Shakespeare Bay can handle vessels of 120,000 tonnes-plus, whereas Lyttelton has a limit of 65,000 tonnes. The venture aims to be competitive with rail exports of coal through Lyttelton. Providing long-term shipping contracts are secured coal volumes being shipped through Shakespeare Bay could reach 4.7 MTPA by 2010 (Crown Minerals, 1999). The Port of

Marlborough has a large stockpile area which can be used to blend coal to customer specifications. The storage facility would be built behind the port on land across the road, hidden from view by hills and bush; a covered conveyor belt would carry the coal from there to the ship or barge at the wharf so Picton residents and visitors to the bay would not be aware of the coal stockpile. A watering system would be provided to give instant dampening should wind levels start to cause coal dust to lift.

11.6.2 Barging Logs

A proposal to barge logs from Port Underwood to Shakespeare Bay has been allocated funding by Transit NZ under the TDM, rail and barging category, with $392,000 available for the project over 2 years. Transfund noted that it would reduce the number of logging trucks using Port Underwood Road by 26 trucks per day, resulting in reduced road maintenance costs and reduced environmental impacts and increased safety (Transfund NZ, 2004).

11.6.3 Aggregate Barging

The Port of Greymouth and the West Coast Rock Group have plans to barge aggregate from the Port of Greymouth to Nelson or Shakespeare Bay for transhipment into larger vessels for on shipment to elsewhere (Stapleton, 2004).

11.7 Solid Energy NZ Coal Barge Operations

Solid Energy is investigating 3 new coal ships to transport coal from its Westport mining operations. The deck ships which will be owned and operated by a third party will be barged mainly to its North Island customers including Huntly Power Station and Glenbrook Steel mill. Solid Energy has already trialed shipping coal West Coast to Huntly with Spring Creek coal. This will more than triple the volume of coal Solid Energy can transport from the West Coast with each ship potentially carrying between 10,000 and 12,000 tonnes of coal (Solid Energy, 2004a). Existing coal shipments are use 4,000T barges out of Greymouth and 12,500T out of Westport. Shipping data from the West Coast ports is given in table 11.1.

Table 11.1: 1999 Coal Shipments from Ports of Greymouth and Westport

Port	TPA	Destination and Use
Greymouth	80,000	North Island industrial Consumption
Westport	200,000	Port Kembla near Sydney for blending with Australian coals for shipment to India
	120,000	Lyttelton for loading onto export vessels

11.8 New Zealand Coastal Shipping

Coastal shipping using scours (flat bottomed cargo boats) used to operate extensively around New Zealand up until the 1950s, with services continuing from North Cape to East Cape into the 1970s. Over this period the scours were replaced by roading and rail, then finally just roading. The current New Zealand coastal marine fleet comprises 16 vessels: two oil tankers, three bulk cement carriers, two rail/passenger ferries, one fast ferry and eight cargo ships (CAE, 2003).

11.9 Silica Sand

From 1922 until 1980 the world's purest silica sands from Parengarenga Harbour (North Cape) were mined and barged to Whangarei for bottle manufacture. The commission for the North Cape locals became prohibitive and an alternative source was found from Queensland, Australia.

11.10 Clifford Bay Ferry Terminal

The Interislandline, a business group of Toll NZ, has examined the potential for using Clifford Bay as its South Island port of operations. The proposed new ferry terminal is to be built to accommodate a new generation of Cook Strait ferries and will serve the Inter-Island operation in the future. The new terminal will reduce the travel time on the conventional ferry by 30 minutes and the subsequent car journey to Christchurch by 1.5 hours.

Key features of the project are:

- Construction of a 1,300 m long reclamation and a 1,100 m long breakwater which will extend 1.6 km off shore.
- Terminal buildings, car parks and marshalling areas, ferry berths, rail lines on the reclamation.
- Construction of a causeway across Lake Grassmere.
- Development of a quarry at Stirling Brook.
- Development of a private haul road to transport rock to the terminal construction site.
- Rail marshalling yards, rail access and services corridor along with landscaping and realignment of Marfells Beach Road.

The new Inter-Island ferry terminal would be likely to be based on a joint venture to design, build and operate the terminal in return for a long-term commitment from The Interislandline as the main customer of the new facility.

Figure 11.15: Clifford Bay, Marlborough

Advantages of the new Terminal Include:

- More efficient and cost effective freight and passenger link between New Zealand's two main islands reducing the Wellington-Christchurch trip by around two hours.
- Gains in port costs, fuel costs, time savings
- Reducing ferries from three to two-due to operating across this shorter distance.
- Road access linking directly into State Highway One.
- Readily available marshalling space at Clifford Bay would also allow the creation of a more efficient rail link into the South Island Main Trunk line.
- Interislanderline would not be subject to current port charges.

11.11 Tiwai Point Smelter

Comalco mines bauxite in the Weipa region of north Queensland and ships it (figure 11.16) to their jointly owned smelter at Tiwai Point in Bluff, Southland. The location of the smelter takes advantage of cheap power from Manapouri Hydroelectric Station in the energy intensive aluminium smelting process. The plant has a capacity of 334,000 tonnes per annum. More than 90% is exported to Japan (Co-owner is Sumitomo Chemical Co. of Japan), Korea and other Asian markets.

Figure 11.16: Conveyors loading bauxite onto a waiting ship at Weipa, Far North Queensland

11.12 Glenbrook Steel-Mill and Waikato North Head Mine

Situated at Glenbrook, south of Auckland, and operated since 1966, New Zealand Steel's Glenbrook Steel-mill operates a fully integrated steel mill processing local raw materials of ironsand and coal. It currently produces 700,000 tonnes of steel annually involving a range of flat steel products for both domestic and export markets. New Zealand Steel is unique among world steel-makers in its use of ironsand to make iron and steel. The ironsand comes from the Waikato North Head mine site and concentration plant, situated 18 kilometres south of New Zealand Steel's Glenbrook mill. The ironsand is initially concentrated using double drum magnetic separators, further cleaned before stockpiling. The ironsand is transported as a slurry through an underground pipeline to the mill.

11.13 Taharoa Iron Sand Operation

At Taharoa, on the coast west of Te Kuiti, iron sand is extracted from a pond by a floating dredge then conveyed to an adjacent floating concentration plant for processing. The concentration plant produces between 200 and 300 tonnes of magnetic concentrate an hour. The concentrate is extracted from the raw sand in a series of separation processes then pumped in slurry form to a stockpiling area two kilometres away. The slurry is pumped via two buried pipelines to a single buoy mooring (SBM) 3 km off-shore, where it is transferred to a bulk carrier fitted with special dewatering equipment. The delivery system to the SBM is capable of pumping 2,500 dry long tonnes per hour through two pipelines. With only one vessel currently in operation, the 143,000 DWT bulk carrier *MV Taharoa Express*, ship loading occurs 6 – 8 times a year. New Zealand Steel Mining is investigating the addition of a second dedicated vessel to enhance the supply chain. The Taharoa mine site covers an area of 1,300 hectares, mining commenced in 1972. Since then, New Zealand Steel Mining has provided continuous supply to its North Asian customer base, with peak exports of 2MTPA in the late 1970s.

11.14 New Zealand Oil Distribution

11.14.1 Refinery to Auckland Pipeline (RAP) Marsden Point to Wiri

The Refinery to Auckland Pipeline (RAP) was built and commissioned during the refinery expansion of 1985. The single pipe carries diesel, petrol and Jet fuel in controlled batches from the Marsden Point Oil Refinery, Whangarei under farmland, towns and part of the Manukau harbour to the Wiri Terminal in South Auckland. The Refinery to Auckland Pipeline carried 2.14 MT of refined product to the Wiri Terminal in 2003. This represents 45% of the Company's total production. The pipeline is the most environmentally friendly, safest and most efficient mode of distributing oil products. The annual volume transported via the pipeline to Auckland would be equivalent to over 50 thousand return truck and trailer loads – an average of 140 per day. The energy consumed by pipeline operations (pumping, monitoring etc) is significantly less than any other form of transport available. The refinery is in the process of debottlenecking the RAP pipeline to increase production by adding an additional pumping station. The RAP is owned and operated by the New Zealand Refining Company, a company owned by BP, Caltex, Mobil-Exxon and Shell.

11.14.2 Oil Shipping

Silver Fern Shipping Ltd currently manages 2 vessels, *MT Taiko* and *MT Kakariki that* carry finished product from the oil refinery at Marsden Point to 10 ports around New Zealand. These ports are: Auckland, Mt. Maunganui, Napier, New Plymouth, Wellington, Nelson, Lyttelton, Timaru, Dunedin and Bluff. Silver Fern Shipping Ltd is owned by BP, Caltex, Mobil-Exxon and Shell. Several other oil tankers bring supplies to New Zealand from overseas ports.

Figure 11.17: MT Taiko (left) and MT Kakariki (right)

11.15 Cook Strait Cable - HVDC Electricity Link

A high voltage direct current link (referred to sometimes as the ‘Cook Strait cable’) is an important component of New Zealand’s national electricity grid. The HVDC inter-island link was commissioned in 1965 and was upgraded in 1990. It runs from Benmore in the lower South Island, to Haywards near Wellington in the North Island. It includes 535 km of overhead transmission lines and 40 km of three 350,000 volt DC and two fibre optic telecommunication undersea cables across Cook Strait. It can transfer electricity in either direction, but usually sends electricity south to north. The maximum capacity of the link is 1040 MW. (The winter peak demand on the NZ electricity system is around 6100 MW.)

Transpower is the state owned enterprise that owns and operates New Zealand’s national electricity grid.

12.0 Discussion and Summary

Due to the major costs, environmental controls and consenting uncertainties it is unlikely that there will ever be a major new quarry operation established within the Auckland region. Meanwhile, Auckland is experiencing difficulties in sourcing high quality aggregates for use in its growing road network and the large corridor projects especially in the fast growing northern regions. The continuing banishment of quarry operations to the outskirts of the city coupled with increasing road use, environment controls and quarry extraction restrictions does not abide well for the Auckland Suppliers. It is inevitable that the current Auckland quarries will exhaust their supplies. Prior to this time their supply will not be able to meet the increasing demand and left unchecked will see a dramatic commodity price rise. It is expected that a break point will be reached when imported common aggregate (concrete and roading basecourse) will become economically competition with the locally sourced materials. As imported tonnages increase, the handing systems and distribution channels become more efficient and with time the margins for the supplier would actually increase. When the Auckland aggregate quarries eventually run out, competition between aggregate importers or seabed dredgers would establish a new price equilibrium.

12.1 Is the venture currently economic?

Apart from decorative aggregate, the highest value aggregate is Transit NZ quality sealing chip. Although it comes in varying sizes it is usually the same price (MacHarrison, 2004). The most recent price obtained (from the invariably vague commodity prices) was \$37 / m^3 at the quarry gate (Christie, 2001). Assuming that arrival at the Port of Onehunga is the equivalent of 'the quarry gate', and given that the dry density of aggregate is 1.8T/m^3 then there is \$20.50/T to work within. Other current break points are calculated in table 12.1.

Table 12.1: Calculation of Auckland Aggregate Operating Price per Tonne

Product	Auckland Price/m^3	Operating Price/T
TNZ Sealing Chip	$37.00	$20.50
Concrete Aggregate	$26.00	$14.40
Basecourse (Northern)	$21.00	$11.70
Basecourse (Central)	$19.00	$10.56

The prices given for barging were varied and are considered to be on the higher end of the scale due to associated savings from economies of scale, and the prospect of continued custom attracting a more favourable rate from the barge company. Assuming a 29T truck and trailer units rate is \$2.20/km and the source is within 10 km of the port:

$$Trucking\,to\ port\ cost \approx \frac{\$2.20 \times 2 \times 10km}{29T} = \$1.50 / T \quad (1)$$

For an initial one off barge run on 8,000T from a West Coast river bed via the Port of Greymouth to Onehunga A wharf, the transport cost would be: \$30/T (Coombridge, 2004) plus \$1.50 (Equation (1)) = \$31.50 / T. The price of winning the gravel from the river bed and associated consent costs are unsure, but if it is assumed the operating environment is similar to the Christchurch aggregate industry where gravel is extracted from alluvial river deposits. The costs would tally as in table 12.2:

Table 12.2: Overall Cost of West Coast Aggregate landed in Onehunga

Product	Chch \$/m^3	Chch \$/T	Transport/T	Cost/T
TNZ Sealing Chip	\$21.00	\$11.70	\$31.50	\$43.10
Concrete Aggregate	\$10.00	\$5.60		\$37.00
Basecourse	\$6.50	\$3.60		\$35.10

Inspection of table 12.1 and 12.2 respective right hand columns indicates that the cost of aggregate from the West Coast is around twice and three-fold more expensive than the local Auckland source. This is sign that the feasibility of the venture is still some way off, however the Auckland quarry industry's expenses can only increase. It should be noted that the above analysis makes a number of assumptions. It is likely that the costs associated with wining river gravels on the West Coast are higher than in Canterbury due to the regions remote nature. The cost for the Canterbury aggregate includes the suppliers' margin. Margin is calculated proportionate to all other expenses and as such accommodates risk proportionate to these expenses. For the operator of this venture, the only margin factored into the right hand column of table 12.2 is on a half to a sixth of the final commodity price.

For large projects such as the Albany to Puhoi Northern Motorway extension, in an area of high aggregate demand and poor quality local resource, this scheme could prove remarkably complementary. A roading project, especially a 4 land motorway, requires bulk quantities within a short period of time. As in is on the opposite site of the Auckland metropolis from the main Auckland quarries at Drury, Hunua and Franklin the project would be faced with sourcing the material from inferior West Auckland quarries of the Brynderwyn quarry 80 km to the north. The aggregate price tendered for this project will be substantially higher than the prices in table 12.1. The Kaipara Harbour is already used by Winstone and Atlas to land sand and aggregate and is within 25 kms of the project with good road access to site. The Kaipara Harbour does however present unique challenges for barge craft; with a dangerous barge and minimal draft.

Due to increased demand and production of coal, Sea-tow does not have any barges available for use, especially not a craft committed to this run, in the foreseeable future. They are sourcing another barge in the New Year but this will be kept busy elsewhere. As a comparison, the unit price of coal is $90 to $140/T depending on its end use. After railing it from the West Coast to Lyttelton over half its price is transport related. Solid Energy is currently sourcing 3 new 10,000T barges for transporting coal from the West Coast onto Shakespeare Bay to be transhipped to larger vehicles for export.

Holcim NZ is a company with a direct interest in this project and has looked at this opportunity before. As well as their cement works near Westport they move a large quantity of aggregate and other materials around the country (Elder, 2004). It is likely that situation is being closely monitored by the large companies and owing to the competitive nature of the industry, such analysis is not in the public domain.

New Government initiatives such as Transfund NZ's Alternative To Roading (ATR), Regional Development, and TDM, Barging and Rail categories alter the feasibility equation in favour of imported aggregate. Changes in rail track management and the streamlining of Auckland transport sector governance (ARTA) are promising signs for the schemes future viability.

12.2 Is it otherwise feasible?

12.2.1 Emergence of barging as viable alternative

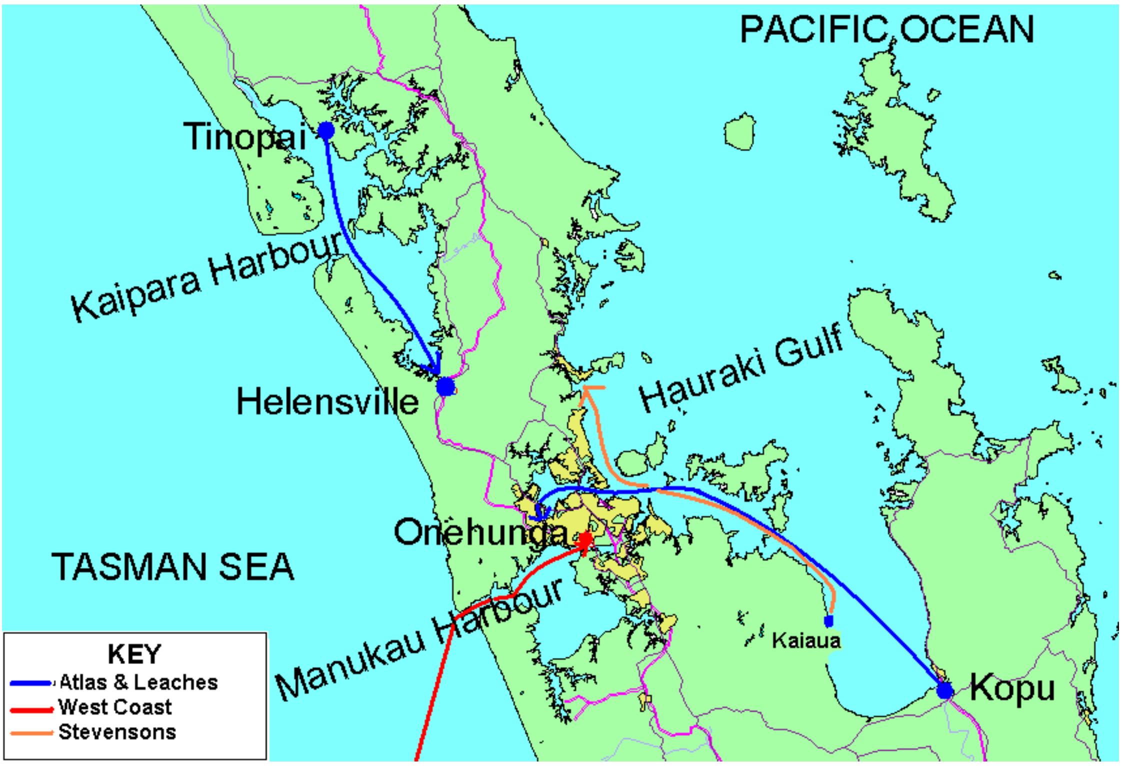

Figure 12.1: Routes of existing aggregate barging into Auckland

The number of current barging operations carrying aggregate into the Auckland region is a promising sign that the mode is feasible. As the market adapts to cater for the alternative mode of delivery, the facilities for receiving and processing the commodity are gradually improved. Figure 12.1 traces the route of the aggregate barge operations know to the author (there are likely to be more). Atlas barge baserock from a quarry at Tinopai to Helensville (section 11.1.1); Leach are developing a barge run with the assistance of Transfund ATR funding from a quarry near Kopu, Coromandel to West Auckland; Stevenson move gravel from their Kaiaua Quarry to Silverdale and Sea-tow lands decorative aggregate from Southland and the West Coast at Onehunga

12.2.2 Sourcing

With further monitoring of rivers by the West Coast Regional Council (a duty required under the RMA to gather information in terms of monitoring and records on natural resources so as to be able to manage the resource effectively) the sustainable quantities available for export can be determined. Financing the council in for future monitoring and research could establish the platform for an enduring commercial partnership. Future council funded emergency gravel extractions could be lucrative. The likelihood of an earthquake, landslide or flood causing extreme aggradation in the region is remarkably high.

The West Coast region is geologically an inverted triangle traced out by the Alpine Fault, the Tasman Sea and its northern granite dominant boundary. The Greenland Group greywacke continue south to where the land tapers off and Alpine Fault broaches the Tasman Sea. East of the fault a band of schist dominates, and due to the unstable nature of the slopes and high rainfall the west draining rivers are festooned with schist bedload material. Greywacke and Granite have shown excellent properties when tested to technical specifications. High grade schist is not considered suitable for top end use. There are areas of apparent quality bedload storage above gorge sections such in the Grey River above Stillwater and in the Inangahua River above the Black's Point section.

The high sediment transfer on the West Coast coupled with the north tending littoral drift is what feeds the growth of Farewell Spit. It is arguable that removal of large quantities of material destined for the sea could adversely affect the current equilibrium. Investigations have reported that the quantity of material involved is of the order of 5MTPA littoral drift (Rendel et al). If removal of 1.0MTPA was to occur it is arguable that this could reduce spit growth from 500m a year to 400m. The effect would not be immediately noticeable and it is not known whether the reduction in supply would be translated to the Cape within 10 years. It is likely that local shoreline degradation would become more immediately noticeable and in such circumstances rates and sources of removal could be revisited. The fact that the Cape is growing also suggests that the system is not currently at equilibrium.

12.3 When will it be economic?

12.3.1 Supply Model

In order to assess the future demand/supply relationship it is necessary to make an assessment on the current aggregate stock un-mined in existing (and almost consented quarries). It is however, extremely difficult to estimate productive capacity for reserves held by producers due to current commercial secrecy. From 1967 to 1993, Crown Minerals and its predecessors published annual quarry production statistics, including statistics for most individual operations. The reserves of a quarry are an important competitive factor as it indicates whether a competing supplier could increase production in the event of a price change by a competitor. From 1994 until present the individual quarry statistics are confidential and only regional summaries are publicly available due to the Privacy Act and other commercial sensitivities. Therefore it is difficult to establish the status of many operations. In the course of this project the author made a request under the Official Information Act to the Commerce Act regarding information of estimated Auckland Quarry reserves provided in papers relating to a share purchase of Atlas by Holcim. The reply follows:

> *"The Commission will not in this instance be able to give out the information required. While the confidentiality period referred to in paragraph 22 of Decision 513 has expired, the information now falls under the Official Information Act process. Under this Act, particularly sections 9(2) (b) and 9(2) (ba), the Commission is declining to release the information".*

The information block was not just restricted to producer companies or the Commerce Commission. Industry customers guard their prices as these are negotiated on an individual basis, by contract and location; Garden centres supplying decorative aggregate are unable to reveal who their suppliers are or the mode of delivery; barge company's, ports and aggregate companies are all quiet about the scope of the current aggregate barging industry or its future prospects. This last instance is likely to be due to safeguarding current clients' commercial interests and the prospects that the port company or council has a commercial interest in future ventures.

The closest data sourced relating to the current aggregate stock held by Auckland quarries is provided in table 12.3 (Byers, 2003 [sourced from Aggregate and Quarry Association NZ]). This data assumes that current supply and demand levels for each site remain constant.

Table 12.3: Auckland Aggregate Supply Outlook (Byers, 2003)

Quarry	Estimated Resource (years)
Drury	25+
Hunua	25+
Bombay	15-20
Atlas	15-20
Clevedon	15-20
Flat-top	15
Waitakere	15
Three Kings	10
Ihumato	10
Ridge Rd	8

12.3.2 Demand Model

As detailed in section 3.1.2, aggregate demand is a function of population; with the Auckland region expected to maintain an average annual consumption of 8T per person. To establish future aggregate demand in Auckland the future population growth needs to be analysed. An inspection of figure 12.2, Auckland Population Growth Rate since 1913, indicates that the regions growth rate demonstrates a sinusoidal curve with respect to time.

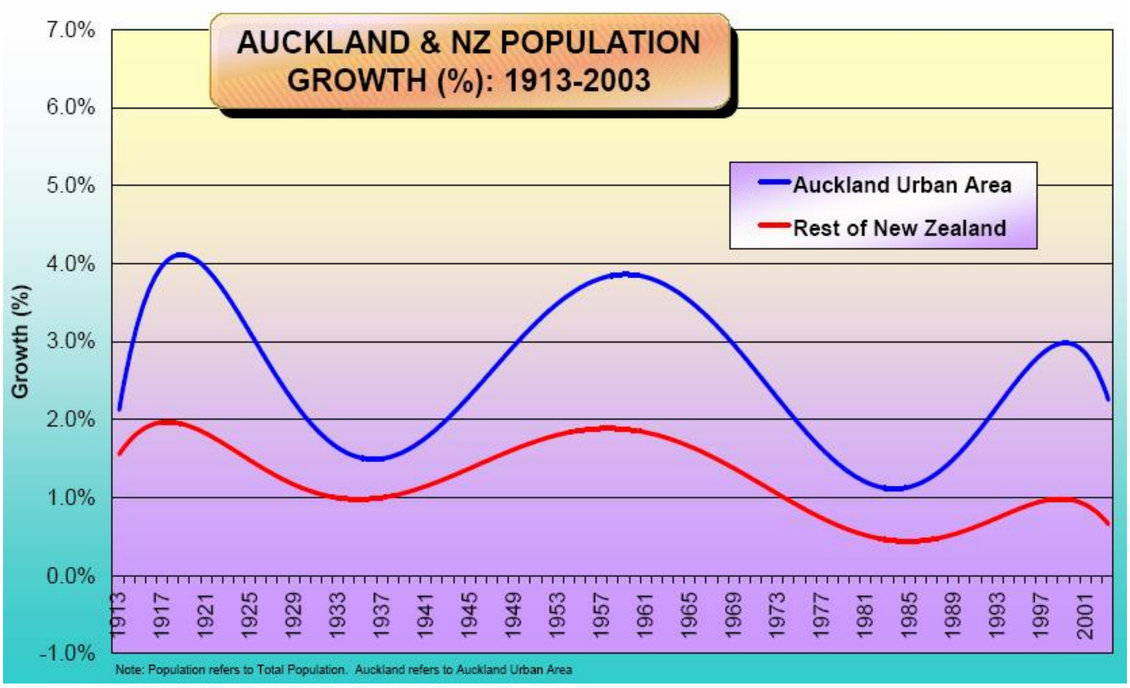

Figure 12.2: Auckland Population Growth Rate since 1913

The trend from figure 12.2 is extrapolated in figure 12.3. This predictive data is used to ascertain the most likely Auckland Population growth curve (figure 12.3).

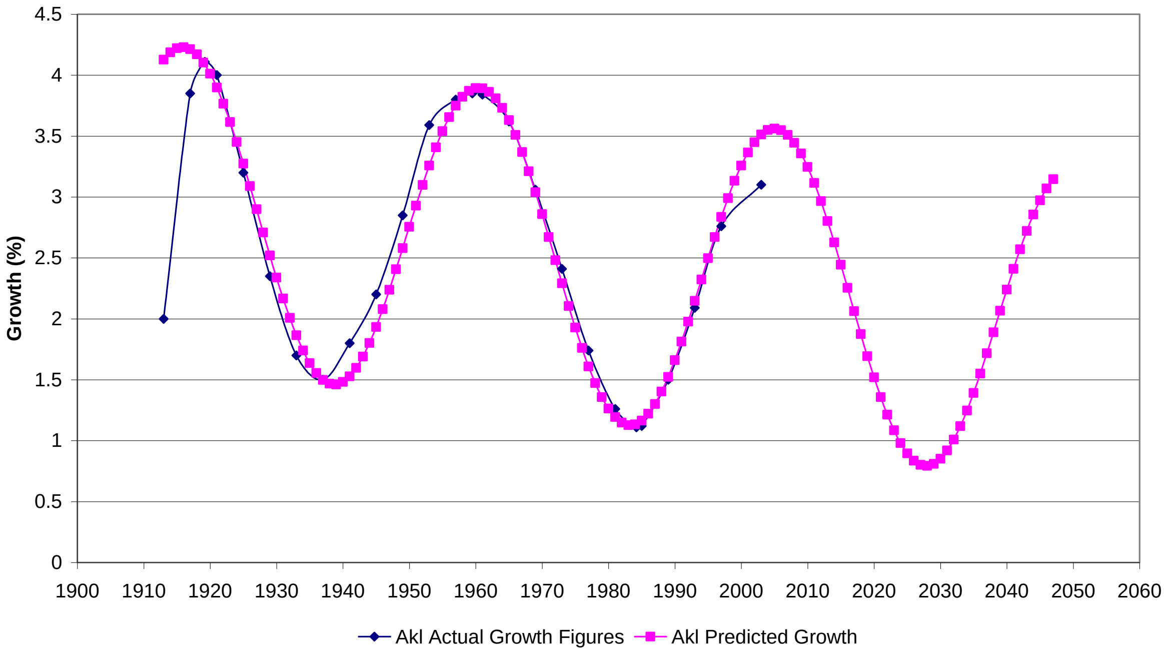

Figure 12.3: Predicted Auckland Growth Curve from Historical Data

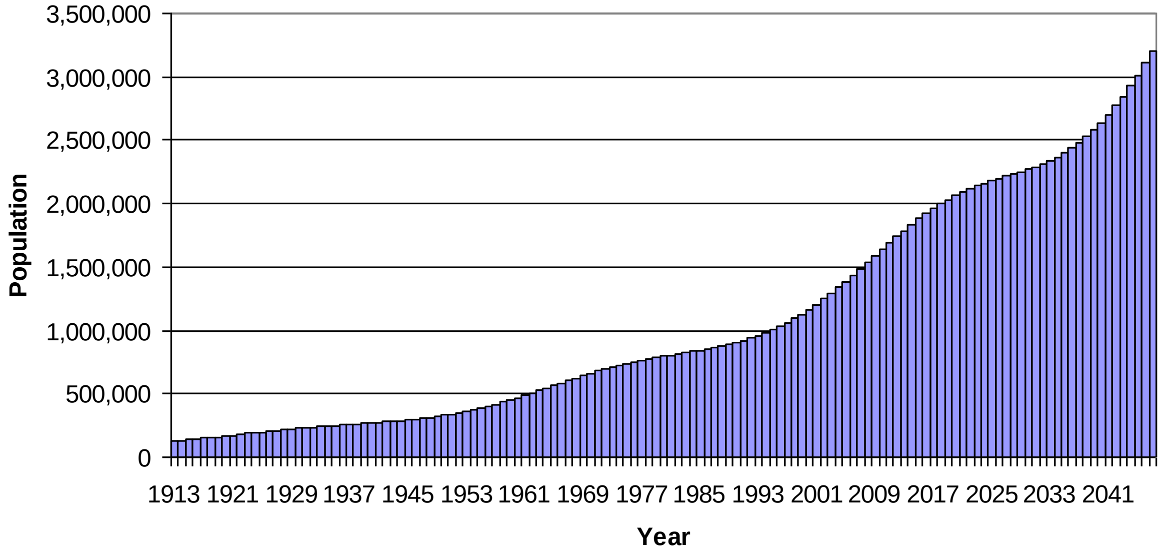

Figure 12.4: Predicted Auckland Population from Historical Data

From the data afforded from the histogram in figure 12.3, yearly aggregate demands were calculated (Appendix 6). The cumulative total demand from the present day onwards is graphed along with highest and lowest calculated aggregate reserves in figure 12.5. The two reserve lines were calculated from data contained in table 12.3. The reserve values were calculated as follows:

a. Since the values given assume that current supply and demand levels for each site remain constant, the values relate to the market demanding 8 times the Auckland population in December 2002 giving a value of 10,152,801 T from then on and into the future.
b. The highest reserve value line assumed that the quarries with 25 + years of reserves would be able to meet this demand, ramping up their production as the other quarries run out. Hence current reserves in this model is:

$$27.5 \text{ years} \times 10{,}152{,}801\text{T} = 279{,}202{,}027\text{T} \qquad (2)$$

c. The lowest reserve value line assumes that the quarries are proportionately contributing to market according to their expected life in Dec 2002. The expected yearly production from each quarry remains the same value as that individual quarry's production in Dec 2002 (point a). i.e. the assumption implies that quarries do not increase production to meet the growing demand and the quoted life is as if they maintain current production. This obvious leaves holes in supply as the other quarries are closed and does not account for the immediate and increasing shortfall as demand increases (due to population growth). The stock of Auckland aggregate reserves is calculated in table 12.4:

Figure 12.4: Auckland Aggregate Supply Outlook (lowest reverse model)

Quarry	*Closing*	**Estimated Resource Life (Years)**	**Assumed Annual Tonnage**	**Quarry Reserves (T)**
Drury	Jun-30	27.5	1,538,303	42,303,337
Hunua	Jun-30	27.5	1,538,303	42,303,337
Bombay	Jun-20	17.5	978,920	17,131,104
Atlas	Jun-20	17.5	978,920	17,131,104
Clevedon	Jun-20	17.5	978,920	17,131,104
Flat-top	Jun-15	12.5	699,229	8,740,359
Waitakere	Jun-15	12.5	699,229	8,740,359
Three Kings	Jun-15	12.5	699,229	8,740,359
Ihumato	Jun-15	12.5	699,229	8,740,359
Ridge Rd	Dec-11	9	503,445	4,531,002
Whitford	Dec-08	6	335,630	2,013,779
Puketutu	Dec-07	5	279,691	1,398,457
Wiri	Dec-04	2	111,877	223,753
Ellerslie	Dec-04	2	111,877	223,753
	Sum	181.5	10,152,801	179,352,166

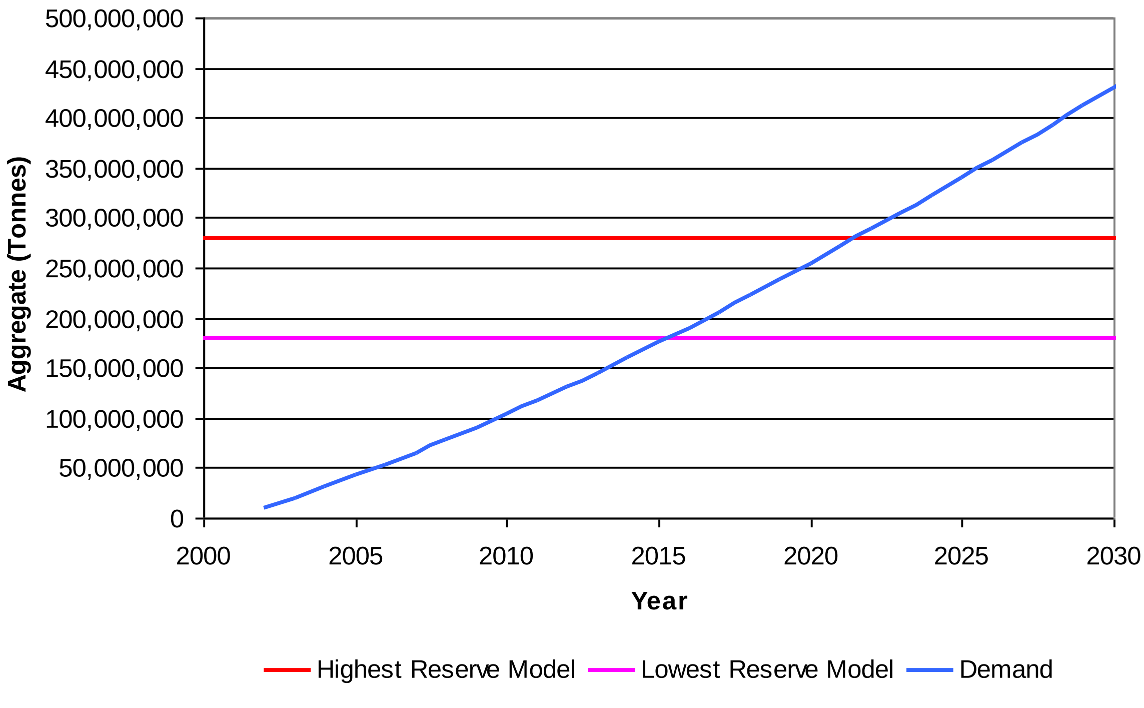

Figure 12.5: Projected Exhaustion of current Aggregate Supplies

From the graph in figure 12.5, the projected demand with exhaust the available reserves sometime between June 2015 and December 2021. The lack of suitable data on the available aggregate stock should be remembered when interpreting this prediction.

12.3.3 Mitigating Factors

Current supply is critical to aggregate pricing and as such construction practices could change to meet shortage. This may only affect the concrete industry who have steel and timber alternatives, whereas the bulk aggregate user (see figure 3.1), the roading industry have limited choice. The use of recycled materials as mentioned in section 6.3 may offset this to some degree. If a quarry is to expand due to increased demand or the closing of another it is constrained by production being limited by its crusher and the ability to feed it. At Hunua Quarry crusher production continues into the evening to help increase production. Reduction in supply will increase price and make entry for alternative aggregate sources to the market more attractive (price dictated by supply and demand).

The large planned quarry at Pokeno is not mentioned in table 12.3. Its ability to economically supply directly into central Auckland is facilitated by its location adjacent to the North Island Main Truck railway line. However it is constrained by consent condition of a maximum yearly production of 1.5MTPA. Apart from the advent of super-quarries such as Pokeno to offset mounting consenting, compliance, transport, traffic control and quality costs, alternative aggregate sources (Slag, dredging and quarrying off shore islands) would become economically attractive and would offset the reduction in resource.

12.4 The Bigger Picture

12.4.1 Growth and Population Control

To address the unchecked population growth and urban spread in Auckland and elsewhere, New Zealand could adopt population policy to address these issues. Developing such a policy could occur alongside economic development strategy, and would need to be carefully considered for its impact on the desirability of New Zealand as a migrant destination.

12.4.2 West Coast Deepwater Port Development

Despite marginal feasibility, the ports of the West Coast were born of necessity from the gold rushes of the 1860s (Appendix1.1). Hazardous harbours were transformed into substantial ports and over time the smaller ports were closed due to the advent of new road and rail transport links. There has been however, some scheme or other for a deep water port on the west coast since 1889 (As detailed in Appendix 1). With the recent and projected increase in industry on the West Coast - especially with regard to bulk materials, there has not been a better time to give this proposition the consideration it deserves. The last time this scheme was considered properly was 1946 and in this time both the economic and technological feasibilities for this venture would have undergone quantum changes.

As mentioned in section 7.1.2.1, the price of New Zealand export coal is hampered by the need to rail it across to Lyttleton or to barge around to Shakespeare Bay. A recent Coal Export Jetty plan at Granity was only supported by Solid Energy. The major industries operating on the West Coast who would have major cost savings with the advent of a West Coast Deep-Water Port include:

- Solid Energy – Coal
- Pike River Coal Company - Coal
- Genesis (in association with Solid Energy) - Coal
- Oceana Gold - Gold
- Holcim - Cement
- Aggregate
- Forestry

With a port, previously uneconomic schemes could become possible. Further extraction of minerals such as iron sand, uranium, asbestos and greenstone could be perpetuated. The possibilities are endless - a water export industry could be developed, cruise ships could visit etc. As is the trend with transport infrastructure, once establish its use grows. Increased industry would have subsequent positive follow on effects; increasing use of adjoining rail links to the port would see then upgraded (e.g. Hokitika-Greymouth Line); under capacity West Coast roads would be upgraded.

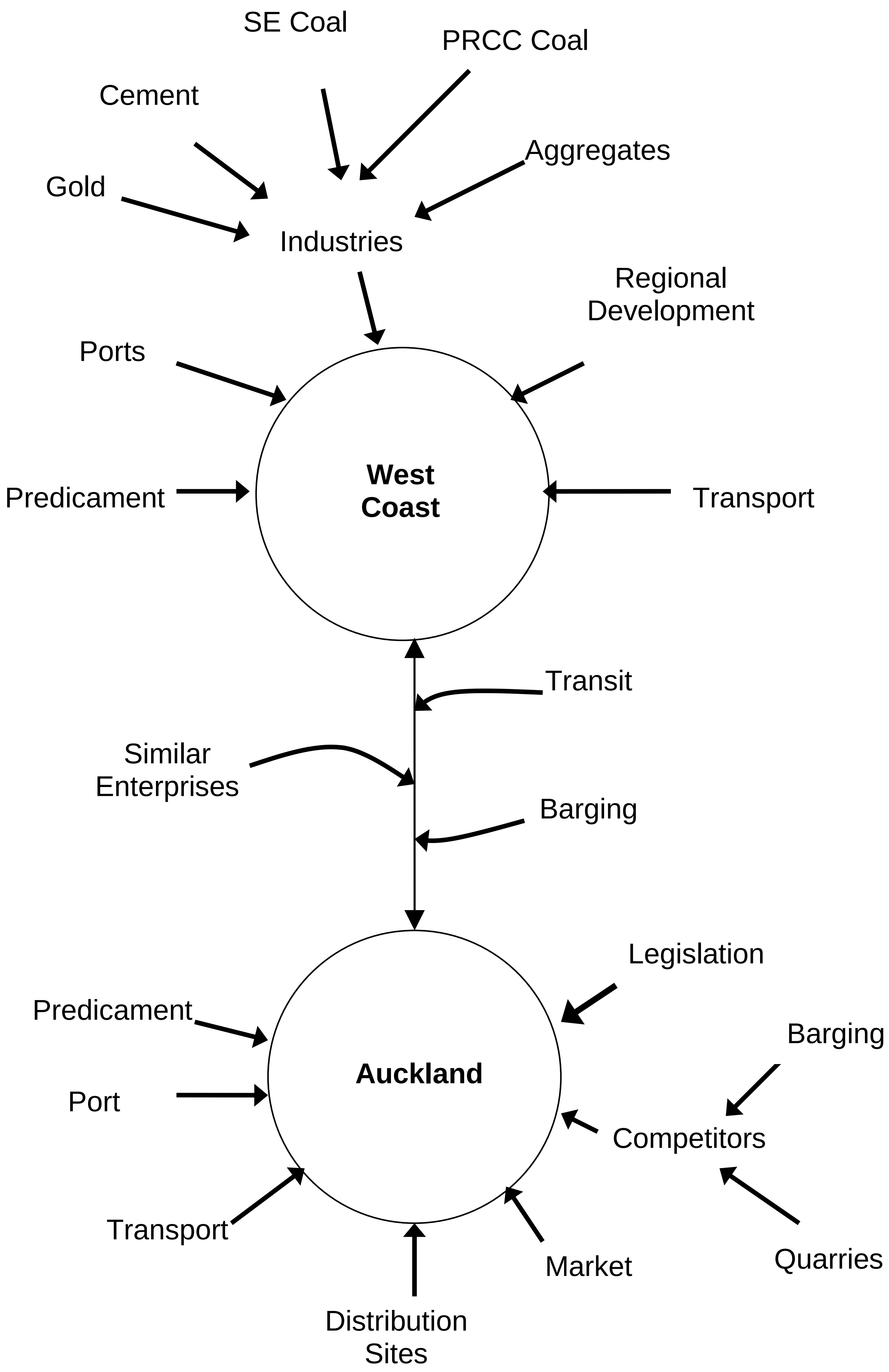

Figure 12.6: The path to port on the West Coast

12.4.3 National Port Development & Coordination Department

The West Coast deep-water port development could be part of a major national initiative on port planning and development. This portfolio used to be the domain of the "Marine Department" with governance delegated to local Harbour Boards who were elected from local citizens, similar to Heath Boards are today. In researching this project, the author has noted the relative malaise exercised by the Government in overseeing port activities. A corollary is the New Zealand land transport structure, which is managed by an overseeing national body. Within the port and shipping markets there is intense competition between ports: between Auckland and Tauranga, between Lyttelton and Port Chalmers and to a lesser extent between Westport and Lyttleton. The effective overall planning of seaports, railways, road transport and coastal shipping would be in the spirit of current New Zealand transport legislation and policies. The new Marine Department could oversee:

- Optimising Freight Movement
- Co-ordinating Port Development
- Providing general Information to Industry
- Funding projects – similar to Transit NZ

12.5 Where to form here?

The various elements of a potential schema favouring the proposed endeavour and their interactions are diagrammatically represented in flow chart form in figure 12.7.

12.5.1 What are the Drivers?

Listed below are the apparent programs and procedures that strengthen and promote this projects endeavour. The increasing constraints being worn by the aggregate quarry industry in Auckland seek to drive the operations cost up and in turn the commodity price. The points below that bolster the plan seek to lower the cost of barging and enable the supply of barged aggregate to Auckland to be feasible. The two dynamics are occurring in parallel (represented in figure 12.8) with the overall consequence being the gradual introduction of barge imported aggregate to Auckland.

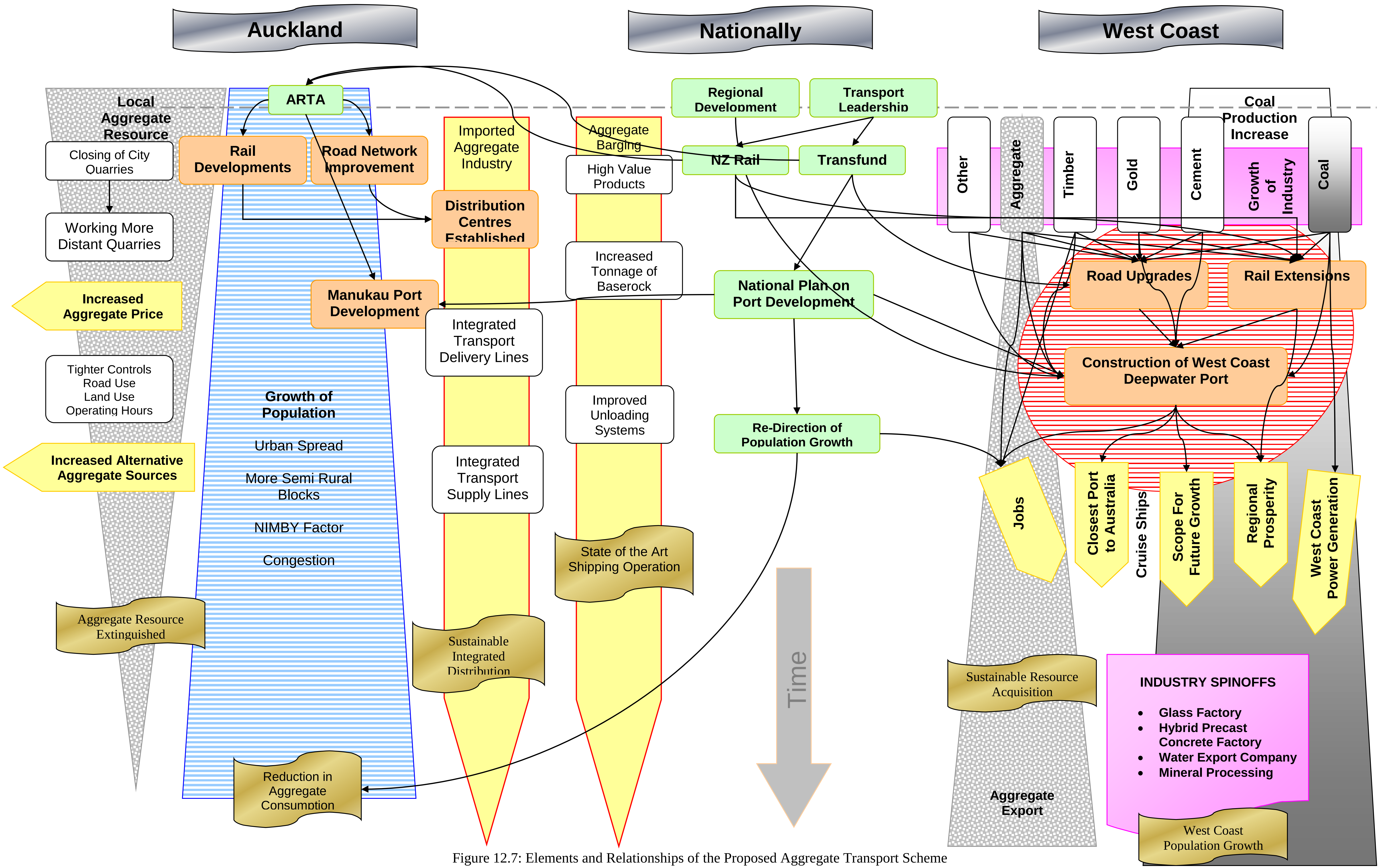

Figure 12.7: Elements and Relationships of the Proposed Aggregate Transport Scheme

Drivers supporting barging:

- Central Government Assistance with Transport Costs through Transfund NZ
    - Transfund "Alternatives to Roading" (section 9.1.3.1)
        - $28M available in 2003/04
    - Transfund "Travel Demand Management, Rail and Barging" (section 9.1.3.2)
        - $53M available in 2004/05
    - Regional Development Assistance (section 8.2.1.1)
        - Up to $2M for major regional initiatives (Deep Water Port)
    - West Coast Development Trust (section 8.2.1.3)
        - $94M held in trust
    - Assistance from Venture West Coast (Section 8.2.1.2)
    - Upgrading and extension of the Rail network in both Auckland and the West Coast (7.1.2).
- Identifying an economically feasible backload for barging Auckland to the West Coast
- A natural disaster such as flood or earthquake may help provide the aggregate at a negative cost – the Council or Earthquake Commission would pay to get the gravel moved.
- Co-operation with other West Coast Industries to provide an improved industrial outlook on the coast:
    - Employee training
    - Improved road and rail corridors
    - Improved port and handling facilities
    - Possible backloads for West Coast Industry
- Reshuffle of Auckland's local authorities
    - Advent of ARTA and ARH (section 9.1.5.1)
        - Now has a common interest in both port and roading
        - Will be positive to upgrading Onehunga facilities if it reduces demand and wear on Auckland Road Network
        - ARTA outlook is complimentary to the Whitehorns "Distribution Centre" concept (Whitehorn, 1999).
- Enlightened changes to the Resource Management Act
    - Enlightened planning, resource protection and regulation.
    - Special consideration for projects of national interest. Given the recent, Regional Funding Assistance ("Investing for Growth") – what benefits Auckland benefits the country.

- Reducing uncertainty over the outcome of a proposal consent especially with regard to vexatious and time consuming objections.

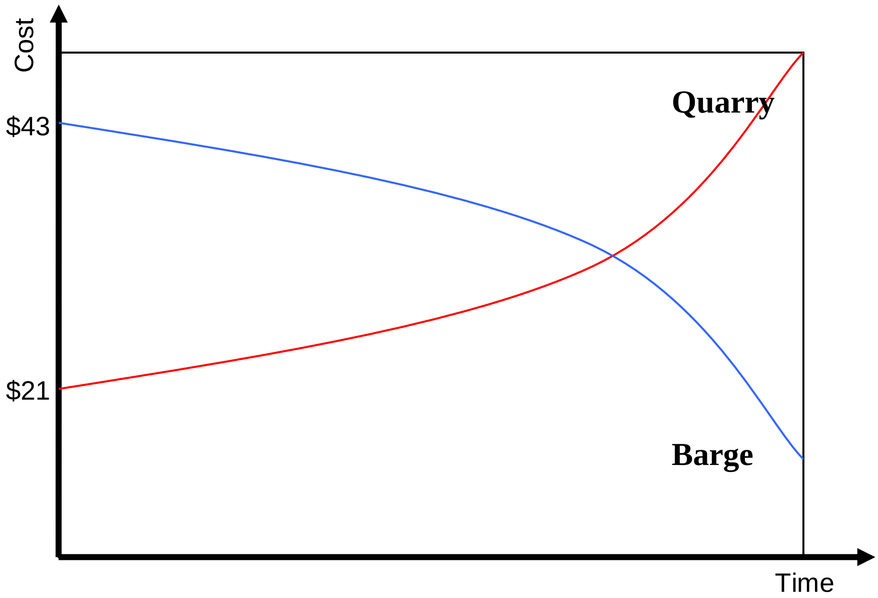

Figure 12.8: Ultimate Price Comparison of Local Quarry & Barged Aggregate

Quarry Operations in Auckland are faced with an increasing number of financial and penalties.

- With the advent of road tolling in the Land Transport Management Act (section 9.1.2), there is a conscious move by roading control authorities to introduce a road tax for heavy vehicle users and affect a maintenance contribution from high impact industries.
- Increasingly, urban encroachment has made for unhappy quarry neighbours, with the possibility of:
    - Compensation for loss of amenity value, slumping, water draw down, dust and noise
    - Sound proofing of nearby premises
- Production restrictions on new and existing quarries (e.g. Pokeno is restricted to 1.5MTPA for the life of the quarry, regardless if it is on sold).
- Increased constraints on establishing a new quarry
    - Many landowners due to ‘lifestyle block’ popularity on the urban fringe
- Existing Quarries Constrained
    - Increased compliance costs through quality controls, health and safety, silt runoff, noise, dust, vibration (from blasting).
    - Increasing environmental pressures – by needing to maintain consents an increasing number of environmental concerns have to be mitigated. This adds further to the cost of the commodity by rigorous procedures and other litigation.

12.5.2 Cost Variables

- The cost given for barging (in section 8.5.1) of $30 per tonne is only indicative and a barge operation is affected by:
    - The price of diesel
    - Economies of scale - if a contractors (e.g. Sea-tow) barge was dedicated to the run, then it would remove the risk of having the barge being out of productive use and a more favourable rate could be offered.
    - The type of barge and size of barge
    - Whether the barges are owned in house or not.
    - The cost and efficiency of port facilities
- General cost variables:
    - Efficiency of the distribution system
    - Market share – further economy of scale.
- If the supply of gravel from the West Coast was interrupted or could not meet demand an alternative supply may need to be sourced which may affect commodity price
- Availability of the Auckland resource - As supplies diminish, the price will increase

12.5.3 Significant barriers to development

The aggregate industry in Auckland is showing the signs of neglect. Although the city has had an insatiable demand for the product, its forefathers have not set aside areas reserved for quarry development (compare this with other Auckland issues – section 2.2). This poor vision for future development is continued today. The short-sightedness in Auckland is paralleled on the West Coast, where local quarryman are more concerned about competition with a neighbouring province than with working together for the common good. Such parochial imperatives saw eight different applications filed for Regional Development Funding within the one West Coast Region. Each was seeking similar outcomes, yet none of them were prepared to pool their resources and make a stronger case.

The Port of Onehunga leaves little room to work; from Thursday to Saturday berths are already booked and not available for use and as there is no storage area, consignments have to be loaded out immediately. There also seems very little enthusiasm to develop either the harbour, the port, storage alongside or even the rail track joining the port to the Main Trunk Line.

As the locality of the target supply rivers coincides with the occurrence of the historically significant Maori greenstone (pounamu) resource, there may be need for special concern. The Arahura River is entirely vested in a local Maori company and the remainder of the resource has been vested with the major South Island Maori tribe, Nga Tahu. The potential for objections to large scale gravel extraction on the grounds of cultural significance appear to be higher than usual.

As there are three major players in the Auckland aggregate market it is expected that they have every intention of maintaining a monopoly on the resource. It is expected that if an emergent supplier became a threat to their dominance, definitive measures would be taken to remedy the situation in their favour.

12.5.4 Distribution Centre Concept

Due to road traffic congestion and the otherwise poor quality of nearby quarries, distribution centres have already been established by Winstone Aggregates and Holcim NZ at Albany and the North Shore respectively. The idea of a distribution centre as proposed by Whitehorn (Whitehorn, 1999) is complimentary to this projects barging proposal. Whitehorns original idea (section 8.83) could be extended to include a small network of strategically sited distribution centres, supplied by various sources (barge, rail etc). Liaison with the Auckland Regional Transport Authority (ARTA), NZ Rail, and Transit NZ could enable future planning to identify optimal sites that could then be serviced by suitable rail, road and or port facilities.

12.5.5 Recommendations

- A close watch should maintained on developments with regard to:
    - ARTA – The dynamics on the answer to Auckland transport governance issues
    - Railways – method of financing track construction and maintenance, pricing structure for access to lines.
    - Barging – the growth of the New Zealand barge fleet to serve the coal, timber and aggregate industry.
    - Transit – the implementation of the alternatives to roading (ATR) funding
    - The barge operation should begin with a high end product to start
        - Such as Sealing Chip
        - As costs mount a break even point with be reached and aggregate with then be progressively sourced from imported source
        - Allows for alternatives to progressively enter the market and establish a presence
    - Develop a distribution centre company
        - Yards and fleet of trucks
        - Establish leading presence
    - Wait until the economic and policy environment is optimal

- Price – reassess basic aggregate prices yearly
- Governance – allow time for the new rail management and ARTA dynamics to become apparent
- Regulations are in place – Changes to the Resource Management Act and impending Sea Bed and Foreshore Act could have major impacts on the future of the proposed scheme.

12.5.6 Further Research

1. Widespread price analysis of Auckland aggregate market, including both trade and cash price for each grade.
2. Location and remaining stock of Auckland aggregate supply.
3. Optimised siting of distribution centres
    a. Co-ordinated with new transport authorities and projects – it is important that these concepts are included in future plans as early as possible.
4. Analysis of the possibilities and impacts of recent developments in the transport sector.
    a. Railways
    b. ARTA sector
    c. ATR Funding
5. Flow chart "Aggregate from River Bed to Auckland Building Site" – an optimisation focusing on intermodal efficiency.
6. State of Harbour Industry
    a. Future development possibilities
    b. Depths
    c. Need for National Port Department (i.e. Marine Department)
7. Framework for co-operation for a West Coast all-weather deep-water port

13.0 Conclusions

Currently, the transport of aggregate from the West Coast of the South Island to Auckland is not economically feasible – but only just. With the escalating aggregate production costs in Auckland, the increasing use of competitive and efficient barging transport and developments in national transport policy this mode of supply will become lucrative. With the eminent exhaustion of the native aggregate resource in Auckland imported aggregate will become the norm.

The market is dominated by three main players: Winstone Aggregates, W Stevenson & Sons and Holcim (NZ). They operate quarries around the Auckland isthmus, but the bulk of production occurs in the large quarries in South Auckland: Hunua, Bombay and Drury. Progressively the city quarries are being closed due to lack of space to expand and on the whole conflicting land use amenity. Distribution centres are operated on the North Shore by Winstone and Holcim on account of the poor local resource and the constriction of the Auckland Harbour Bridge creating on the whole an entirely separate market. Stevenson has likewise introduced a night delivery service to counter traffic congestion constraints. Industry commentators recognise Auckland's demand for aggregate will be steady at 8T per person for the foreseeable future. From the minimal information available quantifying the current Auckland quarry aggregate reserve and from current population growth trends and associated aggregate demand per capita it was deduced that current Auckland quarries will be exhausted sometime between 2015 and 2021.

The West Coast of the South Island is one of the most active in the country in regard to sediment transfer in the regions high energy rivers. High rainfall, seismic uplift and steep terrain all make the area optimal as a source of easily won aggregate. The lithology of the West Coast is predominantly greywacke from the Greenland Group. In the north this is mixed with Tahuna Granite and as the coast and the Alpine Fault converge, the proportion of schist increases the further south the location. Both granite and greywacke exhibit excellent aggregate properties for concrete, roading, sealing chip and railway ballast uses. Apart from the obviously superlative aggradation of the Waiho River, which is known to have risen by 5m in one storm event in 1995, little is known about the bedload replenishment properties of the choice central West Coast rivers. Recent short term monitoring by Temple (Temple, 2001) and the lack of historic signs of over-extraction indicates that the resource is plentiful and that in some constricted basins there is substantial sediment storage.

The roads and rail networks of the West Coast ‘are fit for use’, yet there are notable sections of under capacity. Although this study has no intention to use the Midland Line to Christchurch it is noted that this is operated at near capacity by Solid Energy and that Oceana Gold intend to ship a further 95,000TPA of ore from their Reefton Goldfield to Central Otago for processing. The burgeoning West Coast industries are operating at the limits of the current infrastructure. The once dormant Port of Greymouth along with the Holcim run Port of Westport are shipping coal, timber, aggregate(Greymouth) and cement (Westport). The port at Hokitika has not been used since the 1950s. A wharf at Jackson Bay is used by fishing boats but is apparently constrained through shallow draft alongside. The recent re-nationalisation of the country’s railway infrastructure has lead to immediate upgrading of the Midland line and it is currently being negotiated as to whether the new coal mine operated by Pike River Coal Company will cart the 0.65 – 1.0MTPA along an upgraded State Highway or rail loop to the Port of Greymouth.

The Port of Greymouth and Westport are river ports with dangerous bars. Recent plans by Solid Energy to develop a coal export jetty at Granity have been abandoned in favour of barging coal out of the existing ports for transhipment at Shakespeare Bay (Picton) to larger vessels possibly up to Cape sized for export. The port at Onehunga is also a dangerous bar harbour with a 27 km run between the mouth and the port necessitating a well timed and executed run in and out. The port is connected to the railway network, but this is currently in an unserviceable condition. As one wharf is reserved for the exclusive use of Holcim’s cement ship and with the sole other wharf being reserved for Pacifica from Thursday to Saturday the port has marked constraints for a new user. There is no storage space afforded on site (although there is scope for reclamation) and all consignments have to be carted off site as they are unloaded.

The Auckland transport sector is currently in flux. On top of the government buying back the cities rail tracks, there are and have been significant roading projects undertaken to overcome major traffic congestion issues. Central Government has invoked a nation wide petrol tax to finance a number of projects to alleviate Auckland’s transport woes along with establishing and all encompassing regional transport authority for Auckland. The body will be run similar to Transit NZ, except administering and planning all modes of transport within the city: ferry, train and bus along with the built infrastructure. Amongst the new transport regimes the recently re-empowered NZ Rail is committed to refurbishing the New Zealand rail network.

A Distribution model as put forward by Whitehorn (Whitehorn, 1999) using possibly abandoned existing quarry pits about the city, or other optimised sites serviced now or in the future with rail and arterial road is entirely complimentary to this projects endeavour. Distribution centres are already being used on the North Shore. Aggregate could be barged then railed or trucked to the centre; customer trucks would visit the facility as they would a normal quarry. In the short term, operation of such a centre using outside sourced materials could be a viable method for a new player to enter the aggregate market. Such an operation could also be run with a dedicated fleet of truck and trailer units.

The Auckland market is currently serviced by a number of barging operations: aggregate for use in readymix concrete is barged the length of the Kaipara Harbour. River gravels are barged from the Firth of Thames to Silverdale for use in concrete block manufacture and decorative aggregate is landed in Onehunga from Southland and Greymouth. In the U.K. and on both the Western and Eastern seaboards of the USA aggregate is shipping from ‘coastal’ quarries into big cities for distribution. Over 30% of aggregate in South East England is sourced in this manner. US operations rely on the aggregate part of the haul being a backload for a higher commodity product and on handling systems developed for servicing the major Great Lake grain barge operations.

There have been a number of funding initiatives introduced recently that could assist this endeavour. The West Coast Development Trust is a $94 fund that the Government provided to offset the economic effects of banning native logging. It offers loans and direct investment for new West Coast businesses. The Governments Regional Partnership Programme administered by NZ Trade and Enterprise has $2M available for ‘Major Regional Initiatives’. Transfund who administer monies for the construction and maintenance of the countries roads are also required by law to consider alternatives to roading ($28M available in ‘03/’04) and transferring road freight to other modes such as rail and barging ($53M available in ‘04/’05). There are no incentives from the West Coast Regional Council for gravel extraction for the purposes of flood control.

Currently there are no barges available for use in New Zealand. An 8,000T barge costs $5M and a tug to tow it costs a further $8M. Barges are scarce due to the major increases in coal exports over recent years. This has been driven by the industrial boom in China. The size of barges in and out of Greymouth, Westport and Onehunga are limited by the bar and available depth of water. This is a function on the time of the year, state of the tide, weather conditions, river flow and when it was last dredged. Restrictions on use at the Port of Onehunga equate to the wharf being available for use only 4 days a week and that all aggregate must be removed as it is unloaded. Access to the West Coast aggregate resource is subject to resource consent under the Resource Management Act. The council has published land rules concerning the extraction of gravel from rivers (Appendix 3). There will a finite level as to what the gravel is replenished and conversely the level at which it may be extracted. Access to nearby gravel terraces could supplement the supply although the more weathered it is the lower the quality. How this scheme will be received by local Maori is unknown. Given the sensitive nature of the greenstone (pounamu) resource and its almost exclusive occurrence in West Coast rivers it would be appropriate to maintain an amicable and close working relationship with local and larger tribes. The reception from existing Auckland industry players to an upcoming rival supplier has the potential to be acrimonious.

Currently Solid Energy are sourcing their own barge fleet to help offset the bottleneck reached with the Midland Line operating at capacity, and all of the county's barges in use. This fleet is to be an outsourced design, build and operate operation; which in turn could bring competition to the New Zealand barge scene and potentially lower prices. The restrictions at the river ports are being worked around currently by barging coal to Shakespeare Bay (Picton) to be transhipped to larger vessels for export. Plans for a deep-water all-weather port on the West Coast have been entertained since 1899. The current industrial rebirth on the West Coast, mainly powered by bulk commodity products should see this endeavour serious considered and planned for. Restrictions at the Port of Greymouth such as lack of rail and wharf space are currently being addressed. It is expected that superior loading facilities will be commissioned as Pike River Coal Company begins to ship through the port.

An attempt to represent the contributing entities, their interrelation and the path by which this projects endeavour can see fruition is made in figure 12.7. Given the evolving amicable legislative, economic and investment climate and coupled with the emerging effective planning of seaports, railways, road transport and coastal shipping the inevitability of this projects proposed endeavour is more certain than existing industry players are aware. The continuing penalties for Auckland quarries and increasing demand will see continued price rises. The advent of competing barge firms in New Zealand could see cheaper transport rates and port developments at Greymouth with streamline both time and cost considerations. Ultimately, if a suitable backload could be sourced, aggregate barging is now possible.

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16.0 Nomenclature

AHB – Auckland Harbour Board

AIAL - Auckland International Airport Limited

ARC – Auckland Regional Council

ARTA – Auckland Regional Transport Authority

Au – Chemical Symbol for Gold

BANANA – “Build Absolutely Nothing Anywhere Near Anything” – an acronym for an anarchist.

Basecourse - the layer of a pavement immediately above the subgrade or subbase and directly below the pavement wearing surface extending for the full width of the pavement.

Draft - The depth of a loaded vessel's keel below the water line

DWT – Dead Weight Tonnage

Greenland Group – Forms the largest part of the Western Province base geology, it comprises uniform grey-green quartzofeldspathic greywacke and argillite turbidite deposits that have been regionally metamorphosed to lower greenschist facies, and which displays two phases of folding and well developed axial planar cleavage.

GRT - Gross Registered Tonnage

LOA – Length Over All

MfE – Ministry for the Environment

MTPA – Million Tonnes Per Annum

NIMBY – “Not In My Back Yard”- an acronym for a reactionary.

NZR – New Zealand Railways Corporation

oz - ounce

POAL – Ports of Auckland Limited

Riparian - Of, on, or relating to the banks of a natural course of water

RMS – Resource Management Services

Sub-base - One or more layers of material placed over the subgrade and below the Basecourse layer and shoulder of a road pavement.

TNZ – Transit New Zealand – The national road controlling authority. Writes policy and ‘owns’ the State Highway network.

TPA – Tonnes per Annum

Tuhua Granite – The Greenland Group are intimately associated with intrusions of Tuhua Granite, which is an acid plutonic rock that varies from grey to pinkish-grey biotite granite with porphyritic orthoclase to a calc-alkali or potassic granite with associated gneiss. Tuhua Granite often shows gneissic structures, with well developed banding being present locally.

WCRC – West Coast Regional Council

WODB – Waste oil distillation bottoms

Appendix 1: Historical Perspective

A1.1 West Coast Port History

A1.1.1 Karamea

100 kms north of Westport, Karamea first came to notice in 1874 when four ship loads of immigrants were landed. Lacking roads the settlers were entirely dependant on the port. The main business of the port was flax, timber and dairy and was also the sole point of entry for supplies. In 1914 severe floods affected the port and the settlement starved. In 1926 Karamea was in a much improved condition as a port and additions had been made to the wharf. The 1929 Murchison earthquake destroyed the port leaving the wharf a tangled wreck causing slips in the high country that brought silt down the rivers which in turn piled up in the port area and on the bar.

A1.1.2 Little Wanganui

Little Wanganui was a satellite port to Karamea, 19km down the coast, was shallow and restricted to small craft. By 1929 it had three small wharves and two training walls built to protect the river banks. It too became too shallow.

A1.1.3 Constant Bay and Nile River

20kms south of Cape Foulwind, Constant Bay lies beneath the town of Charleston which mushroomed during the gold rush. The port had a narrow entrance barely 1.8m wide between high shelving rocks. As the port was too risky for insurance companies would not cover ships bound for Constant Bay. Although the port boomed the tailings from hundreds of mining sluices silted up the harbour.

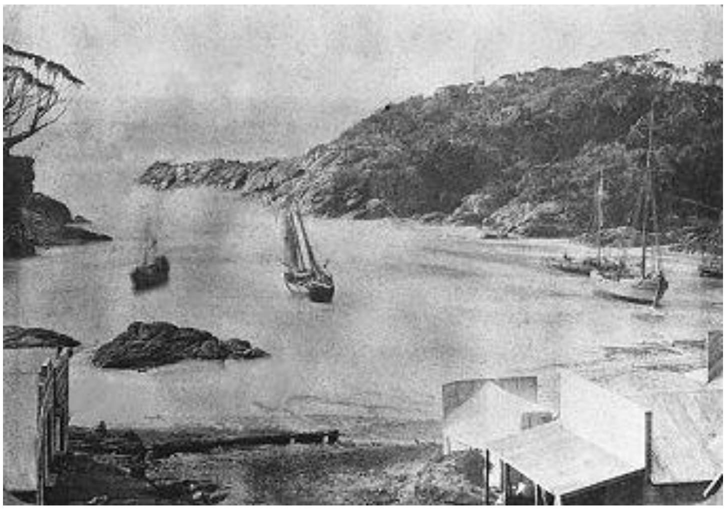

Figure A1.1: Constant Bay and its narrow entrance

A1.1.4 Woodpecker Bay and Fox River

20kms south of Constance Bay was an unlikely spot but gold bred necessity: gold was found in the river and its narrow rock strewn entrance was used as a warehousing port with a small wharf. Roads gradually dispensed of its need.

A1.1.5 Greymouth

At the start of the gold-rush in 1864 Greymouth was already a shipping port.

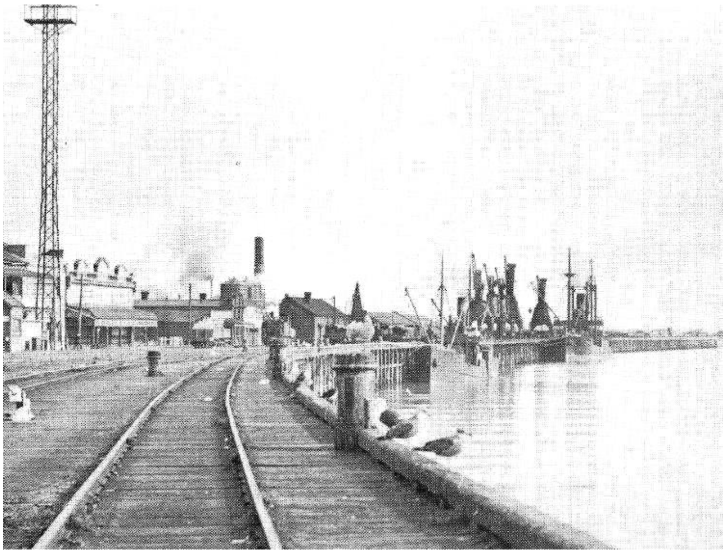

Figure A1.2: Port of Greymouth in its heyday

A1.1.6 Hokitika

Started by impatient prospectors, the Port of Hokitika was established in 1864. By July 1865 after construction works were completed there were 22 ships in the harbour and “many more in the offing”. Its nearby transit shed was handling 500 tons of cargo a week. The entrance to the river was variable and shallow, ran to seaward in a nearly North South direction, forcing vessels entering and leaving the port to do so broadside on the prevailing seas – establishing for itself a reputation for its dangers. The bar was considered safe for vessels drawing up to eight feet of water and since this seemed ample for most of the small vessels they crowded into the river despite the dangers. Within a short time there were many wrecks, no fewer than 21 in the first year. Tugs were used to reduce the hazards of the harbour from October 1865. At a time when few New Zealand ports could boast a tug, the number at Hokitika swelled to 4. They were kept busy. Ships converged on Hokitika from all the coastal ports and even from Australia. One report tells of 41 ships in the harbour, piled three deep, while others were being bustled out to sea to make room for others in the offing.

In 1866 Hokitika was one of New Zealand’s leading ports second only to Auckland and boosted by gold, was top of the list of ports for the value of its exports. In the years 1865 – 1867 there were 108 strandings and 32 ships became total losses. Floods created havoc in the harbour. A side effect of flooding was a tendency for the main channel to divert into a southern channel leaving the wharf area too shallow to work the ships. To deal with this problem, the Marine Engineer was called in and recommended building a dam to block off the southern channel. This was done and although on several occasions the dam itself was carried away by floods; a stronger affair of sunken pontoons and piling appeared in 1867, but this too was washed away by a major flood closing the port and the flood carved out a southern entrance which for a while was used by shipping; but vessels using this temporary entrance were unable to go up to the wharf and were unloaded in the mouth. For a while there were fears that the entrance would cause a loss of trade at the port and the local paper reported "from the proud position of mistress of the West Coast to a mere gap in the beach". Then fortunately, in another flood, the river scoured out the main entrance and by September 1867 the wharf was in use again and as busy as ever. A regular service ran to Onehunga and Dunedin and Nelson, also enjoying a direct trade with Melbourne and other Australian ports. Hokitika was the 'capital of the Coast'. But as the Arthurs Pass route was opened up and gold petered out Hokitika never regained the peak years of 1866 and 1867 and in a flood in January 1868 the river banks eroded undermining some of the buildings, marking the end of an era.

Two breakwaters at the entrance and a new dam across the south channel were commissioned to prevent a recurrence of the events of 1867. The breakwaters extended out in 180 meters in a curving channel 120 m wide. The controlled harbour entrance was similar to Westport and Greymouth except it did not share the lucrative coal trade. From the time the works were completed the Harbour was in decline. However in 1913 with increased population and trade they were able to extend the breakwaters and increase the draft available. Shortly after the western breakwater collapsed and was never to be repaired. There were 39 wrecks in the nineteenth century and 2 in the twentieth. In 1950 the port was declared closed and has not been used since (Stapleton, 2004).

A1.1.7 Lake Mahinapua

In 1879 imminent harbour architect, Sir John Coode foresaw the possibility of a navigable channel for barge traffic by way of the Mahinapua River to Lake Mahinapua, 7 kms to the south of Hokitika. In 1945 the Westland Progress League took up Coode's vision further – the harbour was to be excavated to 17m, would be 900 acres in extent and its entrance was to be cut through the narrow strip of land separating the lake from the sea.

A1.1.8 Okarita Lagoon

It was proposed that to exploit the southern beech forests, a new port might appear in the Okarita Lagoon, 80 kms south of Hokitika. In 1865 Okarita was gazetted as a port of entry and by 1866 the gold rush made Okarita the third busiest port on the West Coast. Between February and April that year 76 ships used the harbour, there was a regular service to Hokitika and the press reported that it was well on its way to being a rival to Hokitika. The port expanded rapidly as a supply centre for the surrounding area and to the south. There was no harbour works undertaken, the lagoon in its deeper part provided safe anchorage and a small wharf was built. The population dwindled and the port virtually ceased to function. In 1905 a revival movement petitioned the government for monies to develop the port. They replied with Submarine mariners to carry out demolition of the obscuring sandbank at the entrance with explosives. The mail service served the settlement. The locals petitioned the government on further occasions, getting a wreck removed from the entrance and then getting a new wharf built in 1906. Further lobbying saw an engineer report on more permanent works, he proposed to stabilise the shifting nature of the entrance with moles. In 1934 the government handed over the port to a local company who began work on the proposed changes with plans to ship out timber and flax. However the entrance began to change its position and by the time the wharf extensions and mole was completed the expense works had been bypassed by a new entrance 400m to the north. After attempts to block the new channel and encourage the tidal flow back through its old entrance failed, nature diverted the water back to its old course and blocked the new channel. There was 4.25m of water at the bar and in 1939 the first and last cargo of timber left the port. The port company went into liquidation in 1941. Although the *Rendel et al* study of 1946 (See section A1.2.1) was focused elsewhere it made comment that Okarita was not likely to be more than a bar harbour, that a south mole and some dredging might stabilise and improve the channel but did not make any firm recommendations. The wharf was repaired in 1947, another engineer did a report on the permanent restoration of the port, and in light of the cost the government Marine Department filed it away.

A1.1.9 Bruce Bay

Bruce Bay is 80 km south of Okarita. Originally settlers and supplies were landed precariously on the beach and a service ran from Bruce Bay to Hokitika from the 1860s. In 1899 a petition to the government for a wharf was not supported because of the exposed nature of the bay. In 1908 a proposal was made to erect a landing stage on the off-lying rock known as Flower Pot Rock connected to the shore by a pier. In 1913 a breakwater proposal was turned down, but in 1923 after many setbacks in its construction in heavy seas, the Flower Pot Landing was constructed. It was merely a platform on a rock with a crane connected to the shore with a trestle-like bridge with a wooden rail. It served the locals as well as the Bruce Bay Timber company which shipped timber out in the 1930s in barges. Frequently the waiting ships were forced to put to sea and several barge loads of timber were lost in heavy weather. These conditions plus the situation whereby there was no alternative route by road, led to the timber company to lobby the government to construct a substantial wharf in 1939. War however intervened and by 1945 both the company and the landing had folded.

A1.1.10 Jackson Bay

Jackson Bay, 100kms to the north of Milford Sound, was used by early sealers and whalers and later by the gold industry. Small craft were able to enter the mouths of the Haast and Okuru Rivers, while the larger vessels lay off in the bay. Proposals of a special colonisation settlement in the 1870s saw need for port facilities as the settlers would be entirely dependant on shipping. The Committee for Southern Settlement emphasised the need for a wharf. Arawhata was selected as the principal town and port and reached a population of 300 but failed chiefly due to the lack of wharf. In 1878 an attempt to build a small wharf was abandoned due to lack of money. The settlement suffered from lack of supplies and there was no outlet for their chief produce of sawn timber. An 1879 a Commission of Enquiry into the settlements failure reported that there had been some prejudice against a wharf at Jackson Bay on the grounds that it might replace Hokitika as ‘the nearest port to Australia’. The wharf was not built until 1938/9 when a substantial wharf was needed to land road building equipment for construction of the Haast Pass Road. It was 70 years too late for the isolated settlers who in 1879, said bitterly that their future depended:

> *‘First on a wharf, second on a wharf and third on a wharf’* (Arawhata Settler, 1879)

The wharf became convenient for shipping out timber, 15 ships visited the wharf in 1968 bringing out timber, some of which was shipped to Australia. With the road over Haast Pass the port could be a more prosperous southern port than could be imagined by its first settlers. Protected by Jackson Head from the westerly swell, Jackson Bay is the only natural harbour on the exposed West Coast of the South Island, however it is open to north-westerly weather and the draft at the wharf is limited.

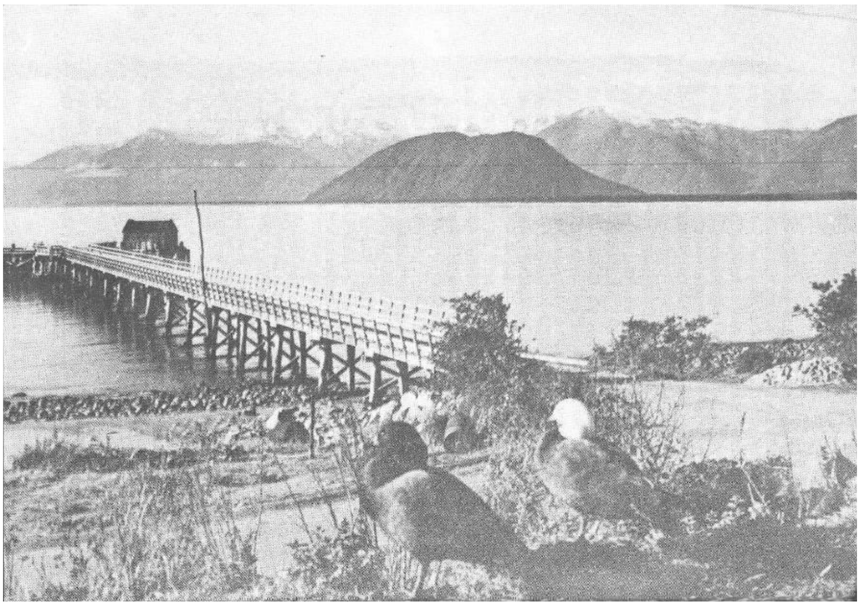

Figure A1.3: Jackson Bay Wharf, 1960s

A1.1.11 Martins Bay

Martins Bay is the northernmost point of Fiordland National Park. In 1870 Jamestown, a settlement at the mouth of the Hollyford River was established in an effort to settle Highland immigrants in the more remote parts of the Otago province. It was believed that the river would be navigable once ‘the bar had been removed’. A vessel called every two months, then only the frequently diverted government steamers, the settlement became destitute and a belated attempt was made in 1908 to improve matters by letting a contract to remove rocks from the river in the hope that it might become navigable, but the isolation defeated the contractor who walked away from the job.

A1.2 The Quest for a West Coast Deepwater Port

The prospect of a deep-water all-weather port for the West Coast has occupied men’s minds for over a century. In 1861 it was commented that the development of the coal industry was more a nautical one than a mining problem (James Burnett – collier engineer), dependant on the discovery and construction of a deep water port. In 1907 whist attending the Imperial Conference in London, the Prime Minister, Sir Joseph Ward was invited to lay proposals before the British Government and as a result the Admiralty instructed a Captain of the Royal Navy to visit the coast and report on the various schemes. The report favoured Point Elizabeth (section A1.2.1) but the Admiralty could see no naval use for it.

A1.2.11946 Study

A special survey of West Coast Ports by consulting engineers Rendell, Palmer and Tritton of London was undertaken for the New Zealand Governments Marine Department. Although there was a number of deep water harbour schemes on offer, their commission was only to advise 'whether Point Elizabeth should be developed as a port to replace Greymouth or both Westport and Greymouth'. The report considered that the basis for a deepwater port on the Coast was a mistake since the idea that a non-river based, artificial harbour would avoid the river silt problem was a misjudgement. It went to state that river bars are formed by littoral drift and that an artificial harbour would suffer in the same way without the advantage of river floods to erode the bar.

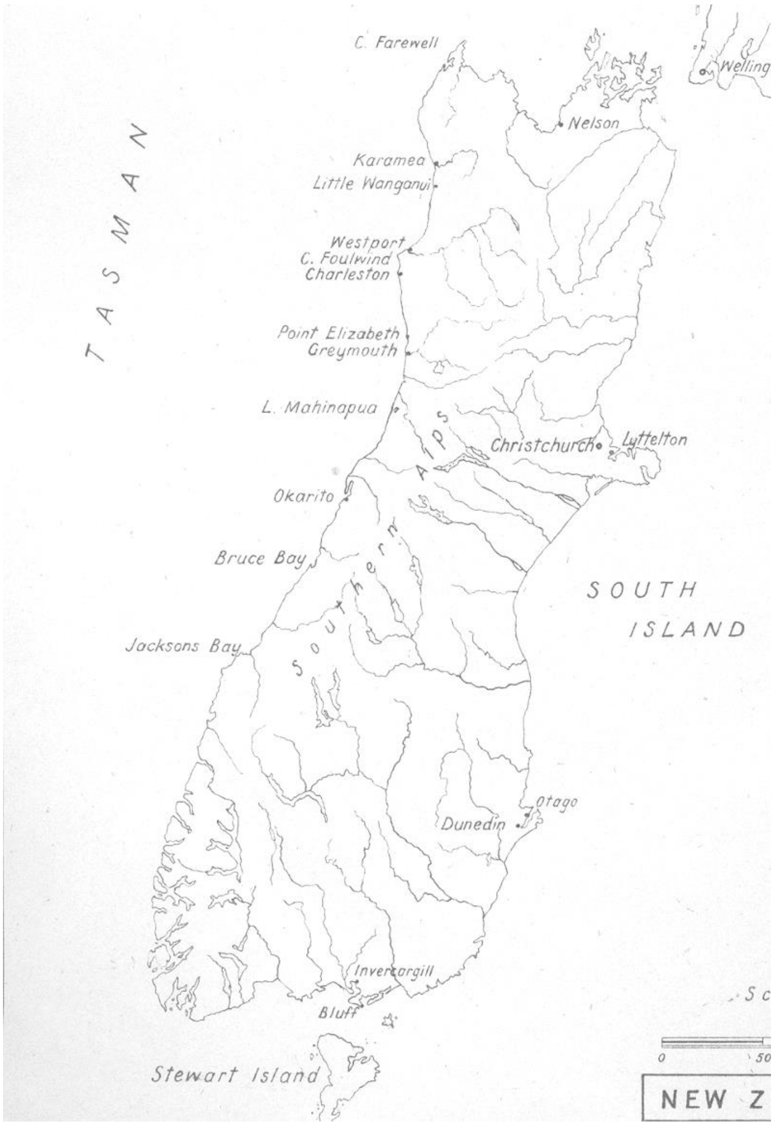

Figure A1.4: Location of 1946 Study's prospective West Coast deep water ports

A1.2.2 Point Elizabeth – Port Curtis

Point Elizabeth is 7 km north of Greymouth and from a relatively featureless coast, the point projects northwards and continues to seaward in a line of rocks, forming a bay about 1.5 kms across. It was identified in 1889 by James Balfour the Colonial Marine Engineer as a possible site for a deep water port basing the idea on the 1868 survey by Lt. G A Woods the marine surveyor. Balfour proposed that a harbour might be constructed here by connecting the extremity of the point to the offshore rocks by a breakwater. He rationalised that it was the only place he had found on the West Coast suitable for a barless harbour of considerable size, its relevance was further advanced by its proximity to the Grey coal fields. He died before he could make detailed examination of the site and nothing was done.

Due to the cost of the major engineering works required being beyond the resources of the province and lack of financing from central government the idea was dropped. That is until; E. I. Lord vigorously took up the Point Elizabeth scheme; taking soundings and gathering other data from which he drew up a plan for an enclosed breakwater port of a similar in layout to Dover in England or Colombo in Sri Lanka (Ceylon) (figure A1.5). Unable to attract the attention of the Government, Lord got backing from a group of London business houses and in 1893 applied to the Marine Department for the rights to the foreshore at Point Elizabeth with the intention of constructing the harbour as a private venture in return for wharfage and other port revenue. The Government was not interested in entertaining the idea. In 1900 Lord turned to the Navy who had plans to increase the naval defences of Australia and New Zealand. He envisioned a harbour which could serve as a naval base and coaling port for the naval squadrons. In 1904 Commander-in-Chief of the Australian Naval Station was interested and offered to send a cruiser to inspect the site, but the Government declined the offer. Later as Town Clerk, Lord persuaded his Council to adopt a resolution calling on the Government to develop the Harbour at the site. The local Member of Parliament suggested that convict labour could be used to construct the harbour and that it should be offered to the Navy as a coaling station. There was a strong local objection to the presence of convicts and the scheme was in competition with several rival schemes for a deep water port. In the face of such rivals, yet another plan was hatched in 1907 – a 1500m breakwater and a lee breakwater of similar length and a detailed drawing of the port complex it would enclose. The harbour was to be 6 times bigger than Lyttelton; its facilities would include extensive wharfage, a graving dock and ‘an anchorage for battleships’. Its estimated cost was £1.7 million. The Royal Navy inspection in 1907 reported favourably on the large harbour. However, The Admiralty, on studying the report recommended that while the harbour might be desirable from a commercial point of view, extensive dredging would be necessary, some of it in hard rock and that costs for the project seemed conservative. The Lordships saw no Naval use for the harbour.

Figure A1.5: Layout of Port of Colombo in Sri Lanka

The 1946 study (Rendel et. al., 1946) focused on the feasibility of a port at Point Elizabeth, noted that the average depth in the embayment is 5.9m with scarcely any low lying level ground for development purposes; the south shore having high cliffs continuing down to steeply rising hillsides. It concluded that the port would also be subject to in fill from littoral drift and was not recommended.

A1.2.3 Westport

A proposal for a huge breakwater at Cape Foulwind (figure 11.12) joining the offshore Steeples Rocks, enclosing a harbour even bigger than that proposed by Lord at Point Elizabeth. Another plan saw the existing breakwaters at Westport extended 180m to seaward and to acquire a dredger to maintain a port to accommodate the largest Navy vessel. The Royal Navy inspection of 1907 frowned on the scheme.

Figure A1.6: Westport 1967

A1.2.4 Charleston

In 1944 the Charleston Advancement League published 'The Case for a Deep Water Harbour on the West Coast of the South Island', proposing a huge breakwater harbour of 100 acres and an alternative proposal to build a harbour by a substantial excavation of Constant Bay and Joyces Bay into a water area of 50 acres.

A1.2.5 Greymouth

In 1925 a special Greymouth harbour commission considered a scheme enclosing the headwaters of the Grey entrance with two huge semi-circular breakwaters which would enclose a harbour capable of receiving the largest ships and replacing the existing port. The idea was dismissed due to the excessive cost of running breakwaters out into deepwater. In 1943 a breakwater port off Cobden was planned, just north of the entrance of the Grey River, complete with oil storage and dry dock. It was proposed that this should be studied by the Canterbury University College School of Engineering but the Marine Department were not interested and the plan was dropped. Maximum draft in 1967 was 6m. The treacherous bar claimed 32 shipwrecks between 1863 and 1950.

Figure A1.7: Shipwreck at Greymouth

> *"An Ultimate Development Plan of the whole port, subject to official modifications at any time but always kept in being, should be prepared incorporating a floating basin on the left bank of the river with rail and road connections and the necessary land should be held or acquired"* (Rendel et al, 1946)

A1.3 Auckland Harbour History

A1.3.1 Kaipara Harbour

The Kaipara Harbour entrance is 64 kms north of Manukau. It is the largest Harbour in New Zealand being navigable over its 100km length from Dargaville in the north to Helensville in the south. Midway between these two lies the entrance with its strong tides, changeable bar and 2 metre rise and fall which has claimed a disproportionate number of ship wrecks. 1839 saw the establishment of timber shipping. During the steam sawmilling era the Kaipara became not so much a port but a conglomerate of minor ports within one great harbour. Port Albert was the last planned colonisation venture in 1863 that never amounted to much and only a small jetty remains (figure 2.15). Helensville, being a short distance overland to Riverhead (Wade) and the Waitemata Harbour became the centre of trade and transport. Two wharfs: the coal wharf and the railway wharf were built by the Auckland Provincial Council in 1872 and three years later the railway link with Riverhead made Helensville an important communication link on the Kaipara. In 1879 another wharf was constructed further downstream at the junction of the Kaipara and the Kaupakapaka Rivers, known as Mount Rex; it was demolished in 1942. By the end of the nineteenth century there were 42 wharves in the greater Kaipara Harbour. Early ferries were frequently grounded on the shifting river sand banks.

The Harbour was notable for its overseas trade with 700 ton sailing ships taking timber and flax to Australia, Britain and European ports. For a quarter of a century Kaipara was New Zealand’s busiest port. One day in the 1880’s 14 deep sea ships were recorded leaving the harbour on the same tide. The Kaipara Bar claimed 43 shipwrecks between 1840 and 1933, plus a tragic number of lives and many millions of feet of timber intended for export. In 1920 the Waterways Commission entered into a proposal for a canal to connect Kaipara Harbour with the Waitemata and for a new deep water port at Shelly Beach; but the plan did not see fruition. The very trade that had given Kaipara its years of prosperity also spelt its doom as a harbour – for as the great forests were levelled, erosion took place and the rivers carried down great amounts of silt to reduce the depth available in the harbour. Although there was still 7 m in the Northern Channel, it was not enough to warrant the development of the Kaipara as a west coast seaport connected to the Waitemata. In 1977 there was talk of the harbour being revived with trade in logs to Japan and renewed interest in the Helensville – Riverhead canal scheme but no decisions were made.

A1.3.2 Waitemata Harbour

The first Queen Street Wharf was begun in the 1850s. This was added to over the years in attempts to provide adequate deep water berthage and by the 1880s the wharf reached out 550m from the shore (Rose, 1971). In the 1910s the wharves were upgraded to ferro-concrete which also facilitated the need to deepen berthage to carry the larger steamers calling at the port. In 1989 a Port Development Plan investigated the future development of the port with consideration given to alternative locations for a major second major port in the region for when the practical limitations of the present port are reached.

Consideration was given to sites in the:

- Upper Waitemata Harbour
- Outer harbour on East Coast (Orere / Ponui)
- Kaipara Harbour
- Manukau Harbour

Of all the sites studied, the most favourable was at Puhinui in the Manukau Harbour. However it was recognised that the west coast has a difficult marine environment and that major dredging would be required at the Manukau Bar.

Traherne Island and Pollen Island

This land was once set aside for port development and associated railway marshalling yards but has been gifted to the Department of Conservation as a Marine Reserve. It would have needed extensive dredging and reclamation to operate as a port replacement.

Te Atatu

In 1949 the Port of Auckland adopted a scheme for port expansion in the upper harbour, some 7,000 acres of harbour bed were vested in the Board by Act of Parliament and 400 acres of strategically placed land was purchased at Te Atatu. It was planned to re-establish bulk oil installations in the area and in the long term it was intended to completely duplicate the existing commercial port there. The feasibility of the scheme hinged on dredging a channel to the Te Atatu site. The Ports of Auckland had set aside land on the peninsular for an upper harbour port replication (AHB, 1975). It would need large civil works to be used as a port including extensive dredging; half the land is currently (WCRC, 2004) leased by a pony club but the council is in the process of “ecologically restoring” the entire reserve.

A1.3.3 Manukau Harbour

The Manukau is the second largest Harbour in New Zealand at 400km^2 (only exceeded by Kaipara). A large part of the harbour consists of tidal sandbanks and navigation is restricted to clearly defined channels (figure A1.8). Although it was realised at an early date that the Manukau, just across the narrow isthmus from the settlement of Auckland presented a shorter route to Auckland for shipping from the west, its status as a seaport has been almost totally dominated by Auckland. The deep water channel that runs along its north was discovered in 1844 and site of Port of Onehunga suggested. In the following years its convenience to an expanding Tasman trade prompted more than one shipmaster, weary of the long haul around North Cape, to express the opinion that Manukau should become the main port for Auckland and in 1853 the crew of a surveying vessel ventured the view still held by many that the harbour could be connected to the Waikato 'at a trifling cost'. Such a canal built at that time would have given barge traffic access to at least as far as Cambridge, 150 km upstream of the river mouth. Although the navigable distance has been shortened by hydroelectric power stations, river barges still have access to Hamilton.

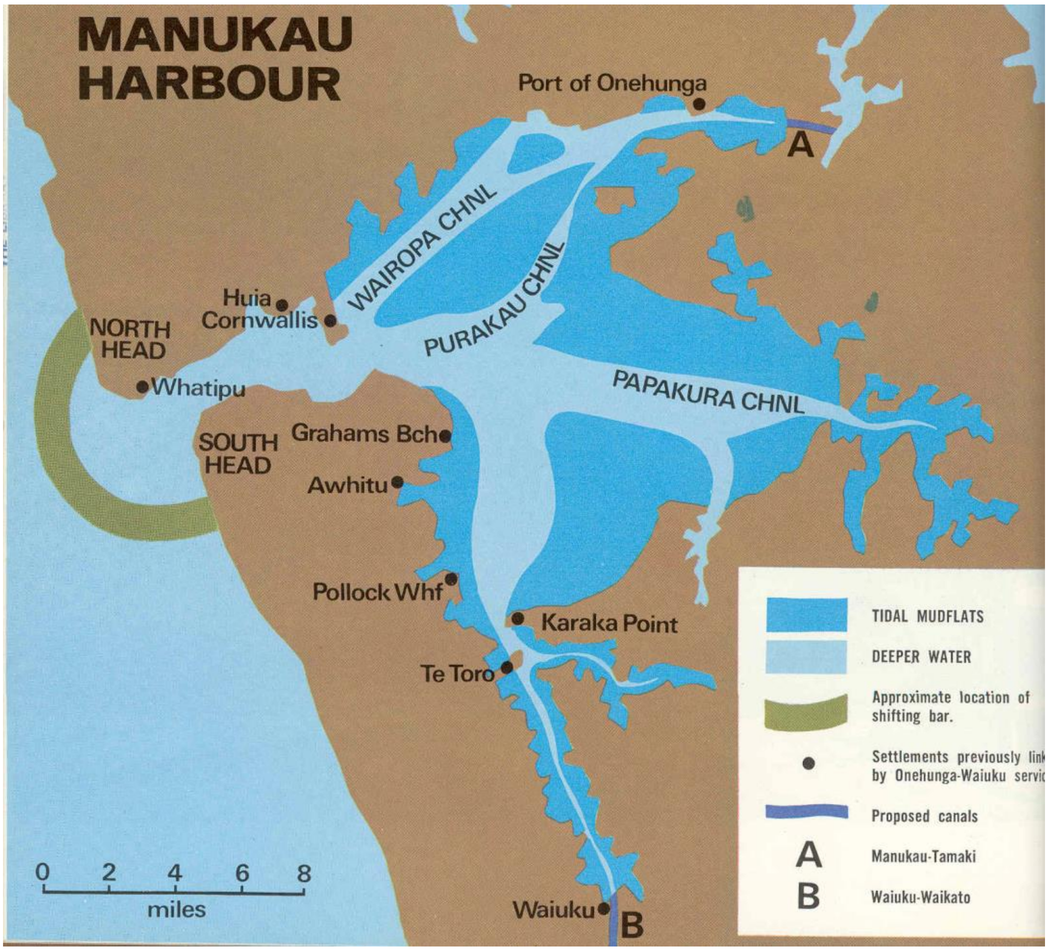

Figure A1.8: The Manukau Harbour channels, bar and proposed canals

The port was used extensively to ferry troops to and from Waikato and later Taranaki during the land wars of the 1860's. In the 1860s small wharves sprung up at Weymouth and Waiuku. Waiuku often referred to itself as "The Port of Franklin" as a steamer went three times a week to Onehunga and often as many as four scows were tied up at the nearby jetty. The service ferrying freight and passengers between Waiuku and Onehunga existed from the 1850s through to 1928 when competition with road and rail made it uneconomic. From another Wharf at Whatipu under Paratutai, iron sand was sent up by barge to the smelting works at Onehunga. In 1863 HMS *Orpheus*, a steam corvette of 1700 tons was wrecked on the Manukau Bar with the loss of 189 lives – the most disastrous shipwreck in New Zealand history. The disaster highlighted one of the limitations that prevented Onehunga from developing into a major port despite being 100 nm closer to Sydney than Auckland. Completion of the rail line between Auckland and Onehunga in 1872 enabled cargo and passengers arriving by steamer services to cross quickly over to Auckland. In the years before completion of the North Island main truck railway, travel between Auckland and Wellington was via New Plymouth. Passengers travelled by steamer to that port and then on to the capital by train.

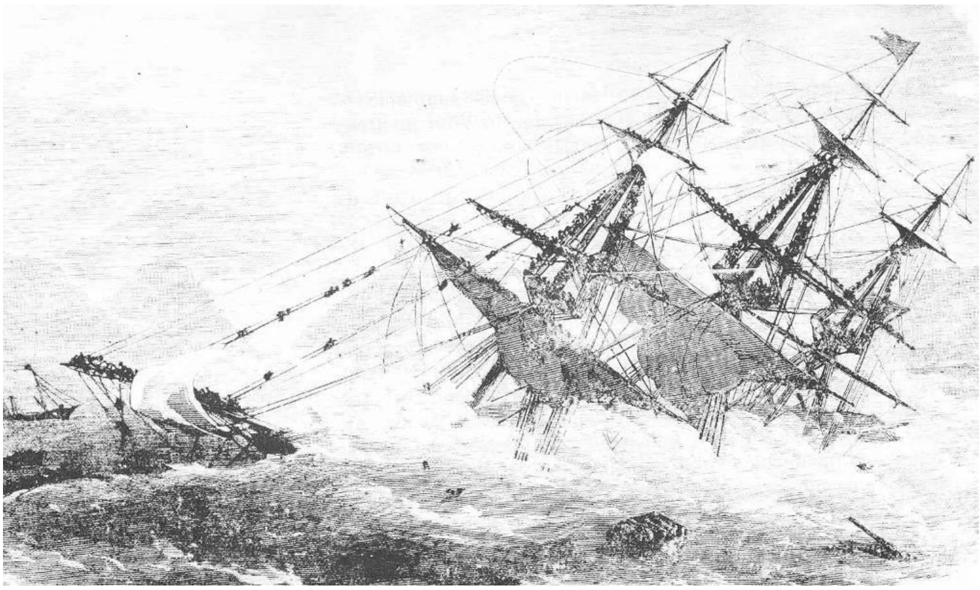

Figure A1.9: Wreck of the HMS *Orpheus* 1863

The present wharf is now 300m long. In 1965 shipping started a run to Brisbane and the Pacific Island reinstating the port as an overseas port. Cement Silos were erected in 1964 and doubled tonnage trough the port in the 1960's. The port handled 300,000 TPA in 1977.

A1.3.4Waitemata – Manukau Harbour Canal

Plans to link the Waitemata with Manukau Harbour via the Tamaki Isthmus were entertained by the Auckland Provincial Council as early as 1860 and were continued through to the 1970s.

In 1922 a Government Commission was appointed to consider the question of canals and waterways in Auckland. The primary object was for Auckland to receive from the West Coast the same benefits it had derived from the East Coast, considered to be the most powerful factor in Auckland's economic development. The commodities of the 1920s were hampered by the loss of time, extra labour of transhipment or both. Any scheme that removed these objections would be of material advantage. Two schemes were considered (Ferriday, 1922):

1. A water connection of dimensions of the Suez Canal – suitable for all vessels including deep sea vessels of greater draft. The scheme involved cutting a deep draft canal to provide for all traffic. The proposed scheme would connect the headwaters of the Whau tidal creek inlet with Titirangi.
2. Comparatively small barge canal involving the cutting of a lighter draft canal through the narrow isthmus at Otahuhu, which separates the headwaters of the Tamaki Inlet on the East Coast from those of the Manukau Harbour on the West

A1.3.5 Whau Scheme

It was considered that the initial and recurring maintenance costs to improve the bar would not be sound economic policy and the first scheme would be limited by the depth of water on the Manukau bar of 6.1m (current depth = 6.1m). This was also the depth maintained across the harbour, except for a few minor shoals, so the cost of necessary dredging would be small. The difference in high water in both harbours is about three hours and represents 3m of water necessitating the need for locks if navigation is to be rendered possible and to protect the walls of the cutting and its approaches from erosion due to the excessive current that would otherwise occur. One lock would be located at Karaka Bay (Manukau end) and another at the point where Great North Road crosses Whau Creek. There was a depth of 3 m at high water under the Great North Road Bridge, increasing to 9.1m at the mouth of the creek, the channel heads toward Kauri Point where the depth is 18.2 m at high water. It was proposed that a channel 6.1 m be obtained and the curves softened to allow vessels 100m in length to navigate; and that the channel would remain open and be swept clean by the natural scour between tides. Lock gates would act as a bridge for Great North Road across the canal, the Kaipara Railway would require a swing bridge and construction of fixed bridge across the higher levels would reroute a couple of lesser roads.

Scheme quantities:

Lengths:

Cut from lock to lock:	3,320 m
Manukau approach	3,650 m
Waitemata approach	9,840 m

Excavations: (Sandstone: Clay ~ 2:3)

Canal:	2,816,400 m^3
Manukau approach	39,000 m^3
Waitemata approach	2,146,000 m^3

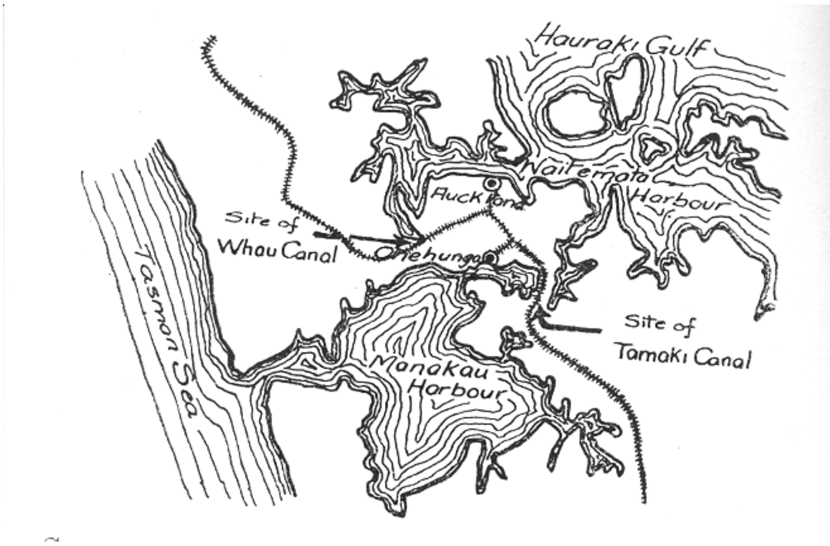

Figure A1.10: Map of 1920s Proposed Canal Scheme

A1.3.6 Tamaki Scheme

At low tide the upper reaches of the Tamaki River and the head of the Manukau Harbour are but mud flats. To obtain a navigable depth for large craft an excessive amount of dredging and extensive embankments and retaining walls would be required. It was thought that a light draft barge canal would be more suited to the site. Two separate routes were considered: one 40 m wide strip known as the Canal Reserve that passes through Otahuhu and the other a little further north, although shorter was not considered as favourable on account of the nature of the countryside and the location or the railway and highway connections. The Canal Reserve was discussed further. The isthmus is only 900 m across with the highest elevation being 12 m. Extensive boring revealed that the isthmus is made up of soft sand, other fine grained materials and pulverised shells. Two schemes were proposed for locks; one being with the Manukau side lock at the (now old) Mangere Bridge and the Tamaki side lock being at Tamaki Bridge 4.5 km below the headwaters A continuous depth of 3m would be maintained. 2.1 km and 3.6 km of the incorporated Tamaki and Manukau respectively would be

Scheme quantities:

Lengths:

Head to head (Land)	914 m
Tamaki approach	2,100 m
Waitemata approach	3,660 m

Excavations:

Canal	325,000 m^3
Tamaki approach	176,000 m^3
Waitemata approach	335,000 m^3

The other lock arrangements would see the Tamaki lock much nearer the Tamaki heads. It was considered that 500 acres could be reclaimed in Manukau Harbour using the spoil of dredging, and if sold for industrial purposes afforded by the canal, could offset the price of its construction. A Council Plan of 1975 saw the canal reserve retained to meet the possible need for an inter-harbour link for barge traffic (AHB, 1975). The Southern Motorway Bridge crossing Otahuhu Creek restricts navigation and future plans by only giving an overhead clearance of 1.95 m (AHB, 1975).

A1.4 Railways

A1.4.1Onehunga – Penrose Branch Line

The first operating section of the New Zealand Railways in the North Island was the Auckland Onehunga Line, a distance of 13 kms. Opened in December 1873 with a good deal of pomp and ceremony, the line was the first built by central government and was a forerunner of the national State-owned system. Connecting the Port of Onehunga with the Port of Auckland via Penrose, the little railway became a busy link between the two harbours of the rapidly expanding city. In those days Onehunga was a busy port despite its treacherous harbour entrance, and was well served by coastal shipping, some of which plied between there and New Plymouth, where passengers bound for Wellington would disembark and continue their journey by train. These “Boat Trains’ were a common feature of the early Onehunga Line. The boat trains were soon able to run down right to Onehunga wharf and in 1878 a small station was sited there, serving up until 1927. By 1897 the service offered 14 trains, mixed goods and passengers. 1903 saw an electric street car introduced which dealt a severe blow to railway. The boat trains finished in the 1920s and a direct service from Auckland to Onehunga finished in 1950, but passenger services ran up until 1973. The 3km, seven minute city branch line between Penrose and Onehunga is no longer even used by shunts to service industries along its length; the entrance to the Port off Onehunga at the railhead has been fenced off and two sea-fright containers have been positioned to occlude the portal under the former Mangere Bridge (figure A1.11 (a)).

(a) Disused Onehunga Branch looking west towards port

(b) Covered in tracks and cement tanks over rail corridor at port, looking east

Figure A1.11 (c): Then and Now [(a), (b) above]. The locomotive is aligned with the position and direction of the photographer in (ii)

The following pictures (figures A1.12 and A1.13) show a now and then contrast of Penrose Station, the Junction of the Onehunga Branch Line and the Auckland-Newmarket Line.

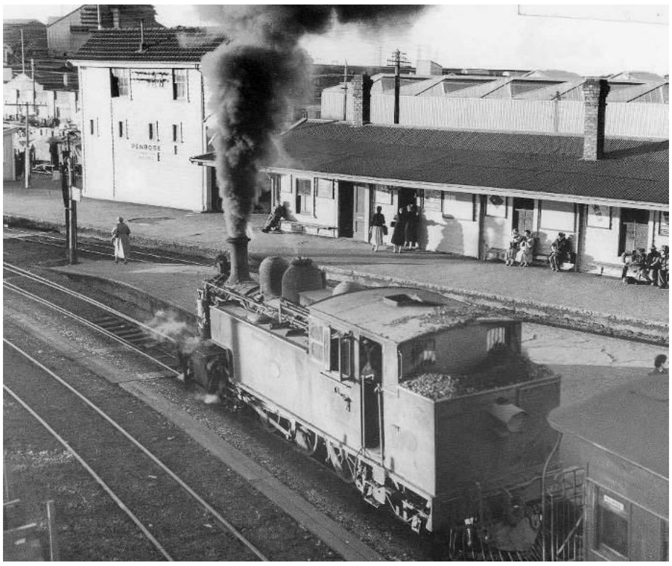

Figure A1.12: Penrose Station and the *Auckland – Onehunga Express*, 1954

Figure A1.13: Penrose Station, 1954

Appendix 2: Slag Overview

Slag is a by-product of the steel industry and is graded according to.

The two main processes at Glenbrook Steel Mill at Waiuku south of Auckland involve iron-making and steel-making, with each process producing a co-product called slag. The slag produced from iron-making is called 'Melter Slag', while 'KOBM' or 'Steel Slag' is produced from steel-making. (Figure A2.1) Melter slag produced at Glenbrook is marketed by *SteelServ* as *Steelstone*.

The iron making process occurs via the reduction of iron ore through a multi-heath furnace. Melter slag is formed through the fusion of limestone, ash and other fluxes such as silicon, aluminium and titanium from iron ore. As the iron is made in a continuous process where the two electric arc melters are never turned off, the melter slag is drawn off at regular intervals and tapped from the melters as a 1500^{o}C liquid. The molten slag is transported in slag bowls to purpose designed tipping banks and cooling pits, where it is tipped and cooled by water sprays and air.

Once cooled, the melter slag undergoes the following process to ready it for sale:

1. Recovery from slag banks
2. Trucked to stockpile
3. Retain in stockpile for minimum of 6 months to weather
4. Recover from stockpile
5. Process through conventional crushing and screening equipment to produce AP40 aggregate
6. Return processed aggregates new stockpile
7. Manage stockpile (maintain correct moisture content/test graduation etc.)
8. Load to truck for dispatch

A2.1 Slag Uses

A2.1.1 Road making:

- Subbase
- Basecourse
- Surfacing (asphalt and chip – TNZ M6 standard).
    - Polished Stone Value (PSV) = 57
    - Mean Summer Scrim Coefficient (MSSC) = 0.62 (High)

A2.1.2 Drainage:

- Waste water treatment – removes phosphorus and heavy metals (world leader)
- Field drains
- Septic Tanks/Soak Holes

A2.2 Properties

- 5% heavier than greywacke
- Has the ability to filter water on a molecular level

A2.3 Transport

In is proposed to transport slag to Auckland via rail, utilising the Glenbrook branch line and using either bottom dumper or preferably side dumper rolling stock.

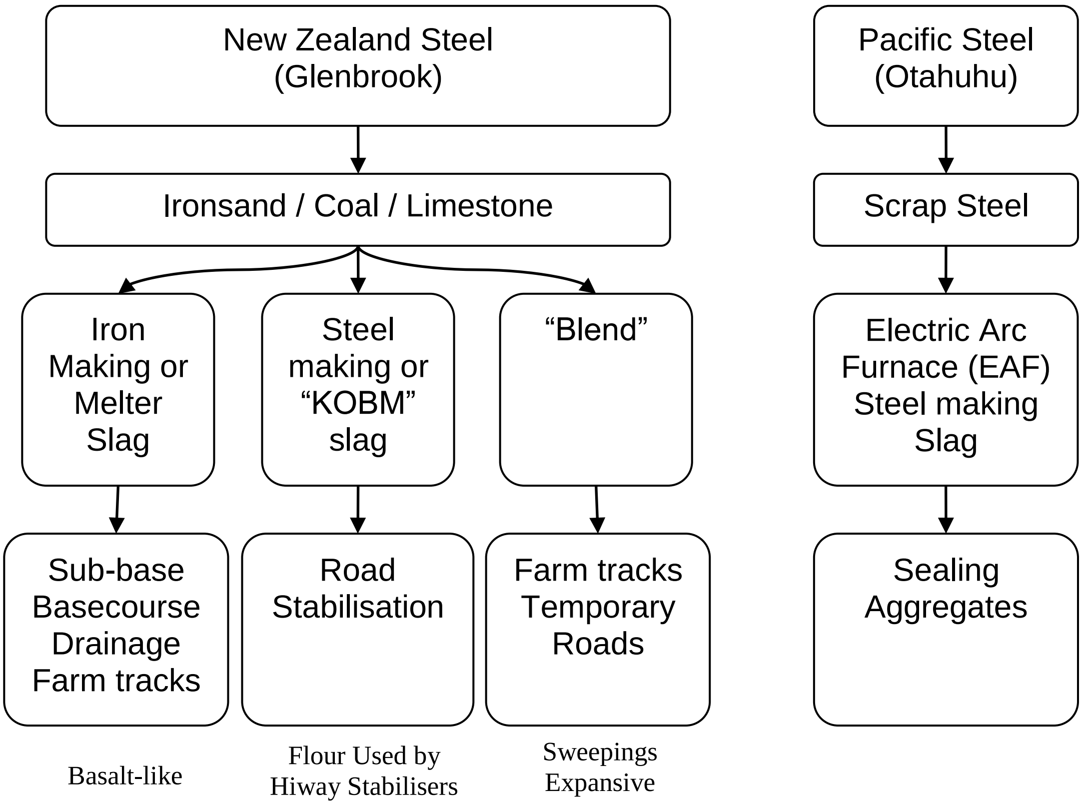

Figure A2.1: Iron and Steel Slags in New Zealand

Appendix 3: WCRC Land Rules

Below is an extract from the *West Coast Regional Council Land Rules;* a policy that covers earthworks, vegetation clearance, humping and hollowing, riparian margins and riverbed disturbance/structures. (WCRC, Land Rules, 2004)

8.2.3.4 Gravel extraction from the bed of a river is a ***permitted activity*** provided the following conditions are met:

(a) The quantity extracted, per person, does not exceed:
- 1000 cubic metres per year, from rivers listed under Schedule A;
- 500 cubic metres per year from rivers listed in Schedule B; or
- 10 cubic metres per month from any other riverbed ; and

(b) Persons wishing to remove gravel must notify the Regional Council in writing of the location, size and timing of the take prior to the take occurring; and

(c) No refuelling of equipment, or fuel storage, is to occur on any area of a riverbed; and

(d) Extraction takes place:
- Only on the dry bed of the river and;
- At least 5 metres from any river bank; and
- No deeper than the level of water in the river and;

(e) Activities do not result in diversion of floodwater, or erosion of any banks, or damage to or scouring of structures and no pest plant is introduced; and

(g) The area from which the material is taken is smoothed over and the site is left tidy on completion of the work; and

(h) Gravel extraction from MacDonald's Creek, South Westland does not take place between 1 April and 30 September inclusive; and

(h) The activity is not undertaken within 50 metres upstream or downstream of any structure including whitebait stands, culverts, bridges and structures used for flood and river protection; and

(i) No more than 1 m^3 per person per year may be taken within 50 metres of the Coastal Marine Area.

SCHEDULE A (1000m^3)	SCHEDULE B (500 m^3)
Arawhata River	Waiatoto River
Turnbull River	Havelock Creek
Okuru River	Ohinetamatea River (Saltwater)
Haast River	Clearwater River
Waita River	Docherty Creek (Franz Joseph)
Boulder Creek, near Moeraki	MacDonalds Creek
Paringa River	Little Man River (above SH6)
Bullock Creek, near Karangarua	Mikonui River
Karangarua River	Donnelly Creek (Ross)
Cook River below SH 6	Kawhaka Creek
Fox River, South Westland	New River
Waiho River	Slaty Creek, Rotomanu (above Station Road)
Waitangitaona River (reach draining into L Wahapo)	Blackball Creek
Whataroa River	Craigieburn Creek
Poerua River (South Westland)	Canoe Creek (Barrytown)
Harold Creek (Hari Hari)	Inangahua River, below Reefton rail bridge
Wanganui River	Devil's Creek (Reefton)
Waitaha River	Mokihinui River, below bridge
Kakapotahi River	Little Wanganui River
Totara River (Ross)	Tidal Creek, Karamea
Hokitika River above 1km upstream of SH 6 bridge	Oparara River, below limeworks
Kokatahi River	
Vine Creek (Kowhitirangi)	
Taramakau River (see note)	
Crooked River downstream of K32 934 415	
Haupiri River	
Nelson Creek	
Ahaura River, below Nancy R confluence	
Grey River, below Waipuna Creek confluence	
Big River (Atarau)	
Rough River	
Mawheraiti River, below Cassoli Creek	
Buller River, below Te Kuha	
Granite Creek, Kongahu	
Karamea River	

Notes: Ngai Tahu own all pounamu (greenstone) previously vested in the Crown. Appendix 3 contains the accidental discovery protocols of the pounamu management plan.

Under Condition 3 the meaning of "person" includes The Crown, a corporation sole, and also a body of persons, whether corporate or unincorporate. This means that a corporation comprised of a group of people or a number of employees is one person. The same applies to an unincorporated group or a family. Individuals who operate together with others, as an incorporated or unincorporated body cannot collectively extract more gravel than what is permitted under this rule.

This rule applies only to the activity of removal of gravel. Persons exercising it should be aware that permission may need to be obtained, at their own expense, from the:

(a) Legal owner or administering body of the bed of the river and of the resource;
(b) The owner of land via which access to the riverbed is obtained;
(c) Holder of any existing resource consent or mining licence for gravel extraction who has prior rights to the resource.

Appendix 4: Contacts

A4.1 Auckland Aggregate Supply

Atlas Quarries
M C Cole – Quarry Pt Contact
09 486 3333
Kaipara Quarries Ltd
09 431 8303

H G Leach & Co Ltd
Paeroa
Eric Souchon - General Manager
0800 108 727
07 862 8727

Steel Serv
Hendrik Wortman - Aggregates Manager
hwortman@multiserv.com
09 375 8593
021 636 204
Bill Bourke
bborke@multiserv.com
09 375 8111 ext 7463
021 129 4073

W. Stevenson & Sons Ltd
Cnr East Tamaki and Paul Stevenson Road
East Tamaki
Auckland
0800 610 710
moreinfo@stevensons.co.nz

Winstone Aggregates
Doug Goodwin - Aggregates Logistics Coordinator
Winstone Aggregates Ltd
0274 921 498
Mike McSaveney - Hunua Quarry Manager
09 299 5702
0274 958 177
MikeM@winaggs.co.nz
Helensville Sand Dredge Operation
Morrie Eyles
025 956 183

A4.2 Comparative Industries

Glenbrook Steel
http://www.nzsteel.co.nz/nz/go/about-new-zealand-steel/operations
<u>Taharoa</u>
Bluescope Steel
07 876 7859
Graham Rewi-Wetini
021 654 973
graham.rewi-wetini@bluescopesteel.com

Hamersley Iron
http://www.hamersleyiron.com/

A4.3 Councils

Auckland Regional Council
09 366 2070
http://www.arc.govt.nz

Buller District Council
Brougham St
Westport
03 789 7239
Jane - Economic Development Officer
ed@bdc.govt.nz
03 788 9111

Grey District Council
105 Tainui St
Greymouth
03 768 1700
Paul Pretorius - CEO
Paulp@greydc.govt.nz

West Coast Regional Council
153 Tainui St
Greymouth
03 768 0466
David Horn – CEO
david.horn@wcrc.govt.nz
Chris Ingle - Planning and Resource Science Manager
0508 800 118
chris.ingle@wcrc.govt.nz

Westland District Council
36 Weld St
Hokitika
03 755 8321
Rob Daniel – Manager Operations
robd@westlanddc.govt.nz

A4.4 Funding Assistance

Grey Region Opportunities Workshop (GROW)
http://www.greymouthnz.co.nz/industry.asp

New Zealand Trade and Enterprise (NZTE)
0800 555 888
http://www.nzte.govt.nz/section/11766/5704.aspx

Venture West Coast
100B Mackay St Greymouth
03 768 5444
venturewc@xtra.co.nz
Pat O'Dea - Chairman
03 789 7679

West Coast Development Trust
Level 1, 112 Mackay Street
Greymouth
www.wcdt.org.nz
0800 768 0140
Timothy King - Business Development / Marketing Officer
trust@wcdt.org.nz

A4.5 Government Bodies

Crown Minerals
http://crownminerals.med.govt.nz/index.asp

Institute of Geological and Nuclear Sciences
http://www.gns.cri.nz/

Maritime Safety Authority
http://www.msa.govt.nz/

Ministry of Economic Development
http://www.med.govt.nz/irdev/econ_dev/infrastructure/reports/pwc-audit/index.html

NIWA
Waimakariri River Aggradation Monitoring
Murray Hicks
m.hicks@niwa.cri.nz

NZ Minerals Industry Association
http://www.minerals.co.nz/html/index.html

A4.6 Other

Aggregate and Quarry Association NZ
http://www.aqa.org.nz

MacMahon Equipment Hire
http://www.macmahon.com.au/Services/EquipmentHire.html

New Zealand Distance Calculator
http://discovernz.co.nz/driving/smlcalc.html

Research Society for Intermodal Transport (Europe)
http://www.sgkv.de/english/index.html

A4.7 Ports

Liquigas
Papakura
Auckland
Warren Hullah
Warren.Hullah@liquigas.co.nz

NZ Sugar Co Ltd.
Chelsea Sugar Refinery
chelsea@nzsugar.co.nz
Tony Grant - Production Manager.
09 481 0864
021 330 249
TGrant@nzsugar.co.nz

Ports of Auckland Ltd
Sunderland St
www.poal.co.nz
09 366 0055
Will Harvey – General Manager Port Services (Onehunga, Marine Services, General Wharves)
09 367 5400
021 866 674
harveyw@poal.co.nz
Wayne Mills – Manager Marine Services (Tugs, pilot boat, lights and Onehunga)
09 309 1266
025 972 390
millsw@poal.co.nz
Ben Chrystall - General Manager Port Infrastructure
09 309 1281
chrystallb@poal.co.nz
Karen Bradshaw - Corporate Communications Manager
09 309 1255
0274 777 501
bradshawk@poal.co.nz
Port of Onehunga
Onehunga Harbour Rd
09 636 4739
Brian Jarman – Onehunga Port Co-ordinator
jarmanb@poal.co.nz
Roy Scott - Harbour Masters Assistant
Evan MacGregor - Southhead Signalman
Signal Station, Waiuku, Pukekohe
09 235 1013

Port of Greymouth
Port of Greymouth Management Ltd
28 Gresson St
Greymouth
David Stapleton – Port Manager/Harbour Master
03 762 5666
0274 353 428

Port of Westport
Buller Port Services (Holcim)
64 Palmeston St
Westport
03 789 7739
David Barnes - Port Manager / Harbour Master
westportharbour-nz@xtra.co.nz
021 959 279
03 789 7249

A4.8 Transport Industry

Sea-Tow Ltd
102 Mokoia Rd
Birkenhead
09 480 6760
www.sea-tow.co.nz
Ian Coombridge - Managing Director
021 990 039
icoombridge@sea-tow.co.nz

Ship Constructors (Ship Co)
Fraser St
Whangarei
09 438 2219
http://www.yellow.co.nz/site/shipconstructors/
Ivor Smith - Construction Manager
Kelvin Hardie - General Manager
shipco-kh@xtra.co.nz
025 220 7503
Pat Ganley - Director of Ship-Co
Ex Sea-Tow

Smith & Davies
09 419 2420

T. Croft Ltd
99 Arnold Valley Road
Greymouth
03 762 5852
0800 105 825
Mr Frank Ash
tcroftltd@minidata.co.nz

Toll NZ
58 Herbert Street
Greymouth
03 768 1413
rpriddle@tranzrail.co.nz
www.tranzrail.co.nz
0800 801 070
Mr Richard Priddle – Service Delivery Manager, West Coast
03 768 1401

A4.9 Transport Govt. Bodies

ARTA - Auckland Regional Transport Authority
C/- Auckland Regional Council
09 366 2000
Geoff Goodwin – Head of Establishment Unit
09 379 4425
Brian Roche - Acting Chair
Victoria Chapman - Secretarial Support
Ext 8112
Victoria.Chapman@arta.co.nz

New Zealand Railways Corporation ("TrackCo")
Head Office Level 4
Wellington Railway Station
Bunny Street
Wellington
David Gordon - CEO
William Peet - Chief Operating Officer
04 299 1044
021 505 852
w.peet@nzrailcorp.co.nz

Transfund NZ
Level 3, BP House
20 Customhouse Quay
Wellington
04 916 4220
http://www.transfund.govt.nz
reception@transfund.govt.nz

Transit NZ
http://www.transit.govt.nz
Wayne McDonald – Auckland Regional Manager
Robin Adams – West Coast/Chch Regional Manager
03 366 4455
021 883 801
Deborah Willet – Communications Manager
04 496 6653

A4.10 West Coast Industries

Holcim (NZ) Ltd
http://www.holcim.com/nz
Rex Williams - CEO
Westport
Cape Foulwind
03 789 7259
Onehunga
Onehunga Harbour Rd
09 634 0312

Oceana Gold
http://www.oceanagold.com/index.php?id=194
Derek Byrne
021 396 145
03 732 8606

Pike River Coal Company
100 Tainui St
Greymouth
http://www.nzog.com.au/pike%20river%20coal%20field.htm
http://crownminerals.med.govt.nz/coal/mining/mines_majordev/pike.html
Gordon Ward – General Manager
03 768 4833
Mine: 35 km north of Greymouth (Crest of Paparoa Range)

Solid Energy New Zealand Ltd
http://www.solidenergy.co.nz
Dr Don Elder - CEO
don.elder@solidenergy.co.nz
0 3 353 0161
021 229 0143
Christchurch
Maurice Watson - Coal Transport Manager (Stockton)
maurice.watson@solidenergy.co.nz
Westport
03 788 8096

A4.11 Westland Aggregate Supply

"Bryce Hope Group"
1495 Eighty Eight Valley Rd
Eighty Eight Valley, Wakefield
03 541 8165
0274 531 734

Southland Sand and Gravel Co.
Cnr. Tweed & Mersey Sts
Invercargill
03 214 4632
sales@sandandgravel.co.nz

Westroads Ltd
267 Kaniere Road
Hokitika
03 756 8044
Mr J Fahey - General Manager
021 278 2133
cws@minidata.co.nz
Westroads Greymouth Ltd
Flower St Extension
Greymouth/Reefton

Appendix 5: Correspondence

Dear David Horn,

I am doing a feasibility study on extracting West Coast river gravels and transporting it for use as aggregate in concrete and roading construction elsewhere in New Zealand.

I will be visiting the Coast on Thursday (19th August) this week and am interested in meeting with you and others from the West Coast Regional Council to discuss the following:

1. Barging through the Ports of Greymouth or Westport
2. Current and future similar activities (Barging, Coal, Gold and Cement Mining)
3. Site visits to rivers and port facilities
4. Synergies with current industries on the coast
5. Limitations and Incentives for such a project
6. Names of further contacts to investigate
7. Scope for increased commerce on the Coast due to unloading of back loads
8. Potential for further spin off industries
9. Increased rail and road use
10. Port access and additional port facilities
11. Flood prone west coast rivers; current flood mitigation and gravel build up concerns.

I look forward to the opportunity to meet with you and discuss this exciting enterprise further.

Best regards,
David Brockett
021 264 0824

Figure A5.1: Example Email Enquiry

Appendix 6: Data

A6.1 Calculations to Determine Idealised Auckland Growth Curve

Variables for Auckland Idealised Growth Trend

amplitude	1.3
period length	0.141
x axis movement	1905
y axis movement	17.3
downward trend in sine wave	0.0075

Variables for New Zealand Idealised Growth Trend

amplitude	0.4
period length	0.146
x axis movement	1906
y axis movement	13.1
downward trend in sine wave	0.006

Auckland's Population

Raw Data	
Year	Actual Figures Growth (%)
1913	2
1917	3.85
1919.2	4.11
1921	4
1925	3.2
1929	2.35
1933	1.7
1937	1.5
1941	1.8
1945	2.2
1949	2.85
1953	3.59
1957	3.8
1959.5	3.85
1961	3.84
1965	3.62
1969	3.06
1973	2.41
1977	1.74
1981	1.26
1984.2	1.11
1985	1.12
1989	1.5
1993	2.09
1997	2.76
2003	3.1

Idealised Data based on trending			
	Akl's Idealised Growth (%)	Auckland Population (predicted)	NZ's Idealised Growth (%)
1913	4.13	126,041	1.96
1914	4.19	131,317	1.98
1915	4.22	136,860	2.00
1916	4.23	142,649	2.00
1917	4.21	148,658	2.00
1918	4.17	154,858	1.99
1919	4.10	161,213	1.96
1920	4.01	167,681	1.94
1921	3.90	174,219	1.90
1922	3.77	180,780	1.86
1923	3.62	187,316	1.81
1924	3.45	193,778	1.75
1925	3.27	200,122	1.69
1926	3.09	206,302	1.63
1927	2.90	212,283	1.57
1928	2.71	218,032	1.50
1929	2.52	223,528	1.44
1930	2.34	228,755	1.38
1931	2.17	233,712	1.32
1932	2.01	238,403	1.26
1933	1.86	242,847	1.21
1934	1.74	247,072	1.17
1935	1.64	251,113	1.13
1936	1.56	255,018	1.11
1937	1.50	258,840	1.08
1938	1.47	262,638	1.07
1939	1.46	266,477	1.07
1940	1.48	270,426	1.07
1941	1.53	274,557	1.09
1942	1.60	278,942	1.11

1943	1.69	283,654	1.13
1944	1.80	288,765	1.17
1945	1.93	294,346	1.21
1946	2.08	300,466	1.25
1947	2.24	307,191	1.30
1948	2.41	314,582	1.35
1949	2.58	322,697	1.40
1950	2.76	331,589	1.46
1951	2.93	341,302	1.51
1952	3.10	351,876	1.56
1953	3.26	363,342	1.60
1954	3.41	375,719	1.64
1955	3.54	389,017	1.68
1956	3.65	403,235	1.70
1957	3.75	418,353	1.73
1958	3.82	434,342	1.74
1959	3.87	451,152	1.74
1960	3.89	468,718	1.74
1961	3.89	486,958	1.73
1962	3.86	505,770	1.71
1963	3.81	525,039	1.68
1964	3.73	544,634	1.64
1965	3.63	564,409	1.60
1966	3.51	584,213	1.55
1967	3.37	603,888	1.50
1968	3.21	623,275	1.44
1969	3.04	642,221	1.38
1970	2.86	660,581	1.31
1971	2.67	678,229	1.25
1972	2.48	695,057	1.18
1973	2.29	710,982	1.12
1974	2.11	725,953	1.06
1975	1.93	739,946	1.01
1976	1.76	752,975	0.96
1977	1.61	765,085	0.91
1978	1.47	776,354	0.88
1979	1.36	786,890	0.85
1980	1.26	796,831	0.83
1981	1.19	806,337	0.81
1982	1.15	815,589	0.81
1983	1.13	824,785	0.81
1984	1.13	834,133	0.83
1985	1.16	843,848	0.85
1986	1.22	854,151	0.87
1987	1.30	865,259	0.91
1988	1.40	877,390	0.95
1989	1.52	890,752	0.99
1990	1.66	905,548	1.04
1991	1.81	921,969	1.09
1992	1.98	940,193	1.14
1993	2.15	960,383	1.20
1994	2.32	982,687	1.25
1995	2.50	1,007,233	1.30
1996	2.67	1,034,126	1.34
1997	2.84	1,063,449	1.38
1998	2.99	1,095,254	1.42

1999	3.13	1,129,564	1.45
2000	3.26	1,166,366	1.47
2001	3.36	1,205,609	1.48
2002	3.45	1,247,200	1.49
2003	3.51	1291000	1.48
2004	3.55	1,336,823	1.47
2005	3.56	1,384,435	1.45
2006	3.55	1,433,555	1.42
2007	3.51	1,483,855	1.39
2008	3.44	1,534,965	1.34
2009	3.36	1,586,482	1.29
2010	3.25	1,637,975	1.24
2011	3.11	1,688,997	1.18
2012	2.97	1,739,098	1.12
2013	2.80	1,787,841	1.06
2014	2.63	1,834,813	0.99
2015	2.44	1,879,640	0.93
2016	2.25	1,922,008	0.87
2017	2.06	1,961,666	0.81
2018	1.87	1,998,446	0.75
2019	1.69	2,032,263	0.70
2020	1.52	2,063,128	0.66
2021	1.36	2,091,141	0.62
2022	1.21	2,116,495	0.59
2023	1.09	2,139,466	0.57
2024	0.98	2,160,411	0.56
2025	0.90	2,179,753	0.55
2026	0.84	2,197,969	0.56
2027	0.80	2,215,582	0.57
2028	0.79	2,233,145	0.59
2029	0.81	2,251,228	0.61
2030	0.85	2,270,412	0.65
2031	0.92	2,291,272	0.69
2032	1.01	2,314,373	0.73
2033	1.12	2,340,260	0.78
2034	1.25	2,369,452	0.83
2035	1.39	2,402,436	0.88
2036	1.55	2,439,663	0.94
2037	1.72	2,481,542	0.99
2038	1.89	2,528,435	1.04
2039	2.07	2,580,653	1.08
2040	2.24	2,638,452	1.12
2041	2.41	2,702,022	1.16
2042	2.57	2,771,486	1.19
2043	2.72	2,846,886	1.21
2044	2.86	2,928,182	1.22
2045	2.97	3,015,238	1.23
2046	3.07	3,107,820	1.22
2047	3.15	3,205,583	1.21

A6.2 Auckland's Projected Demand & Supply Relationship

Hypothetical Census Date: 30-Jun

Akld per capita aggregate demand: 8

30-Jun Year	Auckland Poulation	Demand (Tonnes)	Accumulated Supply Requirements (T) From 2002	Higher Reserves	Lower Reserves
2000	1,166,366	9,330,929			
2001	1,205,609	9,644,876			
2002	1,247,200	9,977,602	9,977,602	279,202,027	179,352,166
2003	1,291,000	10,328,000	20,305,602	279,202,027	179,352,166
2004	1,336,823	10,694,584	31,000,186	279,202,027	179,352,166
2005	1,384,435	11,075,483	42,075,669	279,202,027	179,352,166
2006	1,433,555	11,468,441	53,544,110	279,202,027	179,352,166
2007	1,483,855	11,870,837	65,414,947	279,202,027	179,352,166
2008	1,534,965	12,279,720	77,694,667	279,202,027	179,352,166
2009	1,586,482	12,691,855	90,386,523	279,202,027	179,352,166
2010	1,637,975	13,103,797	103,490,320	279,202,027	179,352,166
2011	1,688,997	13,511,973	117,002,292	279,202,027	179,352,166
2012	1,739,098	13,912,787	130,915,080	279,202,027	179,352,166
2013	1,787,841	14,302,731	145,217,811	279,202,027	179,352,166
2014	1,834,813	14,678,501	159,896,312	279,202,027	179,352,166
2015	1,879,640	15,037,123	**174,933,434**	279,202,027	179,352,166
2016	1,922,008	15,376,061	190,309,495	279,202,027	179,352,166
2017	1,961,666	15,693,328	206,002,823	279,202,027	179,352,166
2018	1,998,446	15,987,564	221,990,388	279,202,027	179,352,166
2019	2,032,263	16,258,107	238,248,495	279,202,027	179,352,166
2020	2,063,128	16,505,025	254,753,519	279,202,027	179,352,166
2021	2,091,141	16,729,128	271,482,648	279,202,027	179,352,166
2022	2,116,495	16,931,956	**288,414,604**	279,202,027	179,352,166
2023	2,139,466	17,115,730	305,530,333	279,202,027	179,352,166
2024	2,160,411	17,283,291	322,813,625	279,202,027	179,352,166
2025	2,179,753	17,438,023	340,251,648	279,202,027	179,352,166
2026	2,197,969	17,583,753	357,835,400	279,202,027	179,352,166
2027	2,215,582	17,724,656	375,560,057	279,202,027	179,352,166
2028	2,233,145	17,865,156	393,425,213	279,202,027	179,352,166
2029	2,251,228	18,009,826	411,435,039	279,202,027	179,352,166
2030	2,270,412	18,163,296	429,598,335	279,202,027	179,352,166
2031	2,291,272	18,330,177	447,928,512	279,202,027	179,352,166
2032	2,314,373	18,514,986	466,443,497	279,202,027	179,352,166
2033	2,340,260	18,722,081	485,165,578	279,202,027	179,352,166
2034	2,369,452	18,955,616	504,121,194	279,202,027	179,352,166
2035	2,402,436	19,219,489	523,340,683	279,202,027	179,352,166
2036	2,439,663	19,517,304	542,857,987	279,202,027	179,352,166
2037	2,481,542	19,852,333	562,710,320	279,202,027	179,352,166
2038	2,528,435	20,227,477	582,937,797	279,202,027	179,352,166
2039	2,580,653	20,645,227	603,583,024	279,202,027	179,352,166
2040	2,638,452	21,107,617	624,690,641	279,202,027	179,352,166
2041	2,702,022	21,616,180	646,306,821	279,202,027	179,352,166
2042	2,771,486	22,171,886	668,478,707	279,202,027	179,352,166
2043	2,846,886	22,775,088	691,253,795	279,202,027	179,352,166
2044	2,928,182	23,425,453	714,679,248	279,202,027	179,352,166
2045	3,015,238	24,121,905	738,801,153	279,202,027	179,352,166
2046	3,107,820	24,862,557	763,663,711	279,202,027	179,352,166
2047	3,205,583	25,644,662	789,308,372	279,202,027	179,352,166

Tailpiece

"There is much promise in the west"

Lord Baron John Forrest of Bunbury (1847 – 1918)